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The SCIENCE COUNSELOR

Volume XI ★ Number 3 ★ Sept., 1948

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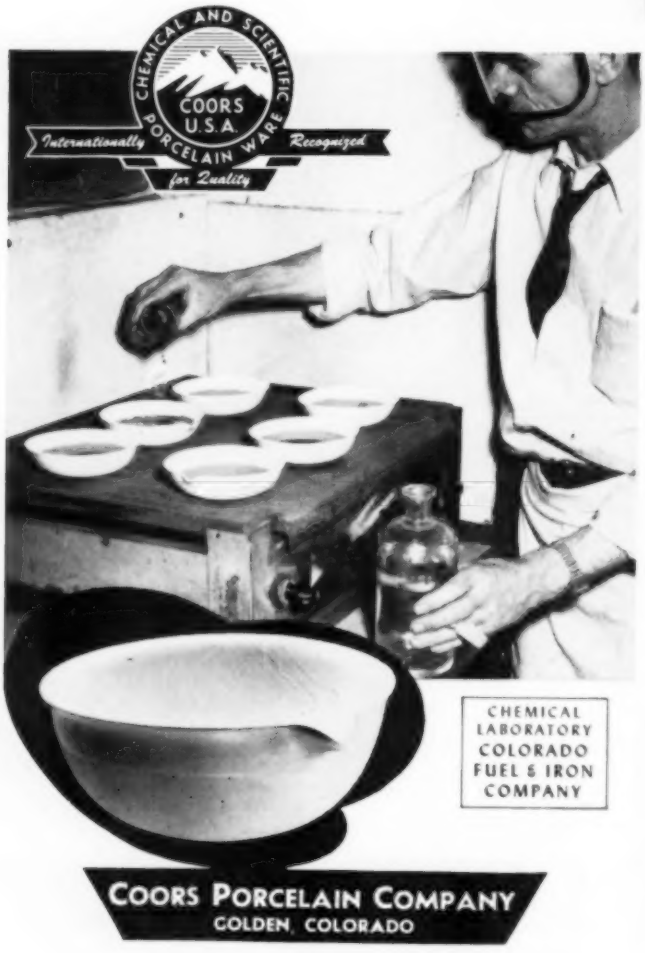

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The Atom in Civil Life
Lewis L. Strauss, Member United States Atomic Energy Commission, New York City.

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Sunspots and Radio Waves
Harlan True Stetson, Director, Cosmic Terrestrial Research Laboratory, Needham, Massachusetts.

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Science—Using versus Learning
Ralph H. Upson, Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minnesota.

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The Salt Industry
William Wilkinson, Vice President, Cayuga Rock Salt Company, Myers, New York.

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Radioisotopes—Scientific Research Tools
Nathan H. Woodruff, Chief Technical Branch, Isotopes Division, Oak Ridge, Tennessee.

Readability of General Chemistry Textbooks
Sister M. Ignatia and Margaret Doyle, Marygrove College, Detroit, Michigan.

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Radar and Its Uses
Captain Jack M. Clark, United States Army, Brooklyn, N. Y.

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The Radio Tube and the Mathematician
Robert R. Seeber, Jr., Department of Pure Science, International Business Machines Corporation, New York City.

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Whole Education for the Complete American
Franklin J. Keller, Principal, Metropolitan Vocational High School, New York City.

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The Manufacture of Breakfast Cereals
Andrew Duncan, Managing Director, Cereals Institute, Inc., Chicago, Illinois.

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The Use of Radioisotopes in Biology
Robert Burris, Department of Bacteriology, University of Wisconsin, Madison, Wisconsin.

Problems of Elementary Science Teaching

• By C. H. Sorum, Ph.D. *(University of Wisconsin)*

PROFESSOR OF CHEMISTRY AND CHAIRMAN OF THE DIVISION OF INORGANIC AND GENERAL CHEMISTRY, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN

Don't miss this article! Give especial attention to its concluding paragraphs.

How has the change in pattern of high school science teaching affected instruction in college? Are high school graduates less capable than formerly of carrying college work in science? What about the diminished emphasis on mathematics, and good study habits, and the disposition to work hard. Is university teaching now less thorough? What should be done?

You may not wholly agree with Dr. Sorum, but you will be interested in what he has to say.

●

One of the outstanding developments of the past fifty years has been the remarkable growth and progress of science and technology. This growth and expansion of science has been a boon to the elementary science teacher. It has given him a wealth of new material, new ideas, new concepts, new theories and new facts from which to draw. It has helped keep his teaching fresh, alive and dynamic. But it has also helped create problems.

Taking the first year college course in general chemistry as an example, the wealth of new material has swelled its content to the point where it can no longer be covered, adequately, in the conventional one-year ten-credit course. We who teach general chemistry simply can not continue to introduce all of the new developments and still keep all of the old material. So we add here and cut there. We are motivated in our adding of what is new by our sincere desire to maintain high standards, to keep our course up-to-date, and to give our students just as much learning as they can possibly assimilate. We are hampered in our cutting of old things by our inherent reluctance to drop something good that we have been teaching for the past 10 or 20 years. But we are impelled to cut by the fact that there are only 18 weeks in a semester, that chemistry is not the only subject that the student is taking and that there is a limit to the amount of material that even the superior student should be asked to learn.

A teacher who is wise will not try to teach any more than he can teach well. But as science grows, as more and more important material gets into our textbooks, it becomes harder and harder for good judgment to prevail. The result is that more and more material is being taught in the elementary chemistry course. Less and less time is being devoted to each topic. The thoroughness with which each topic is presented has, of necessity, decreased.

This decrease in thoroughness of university teaching is coming at a time when, actually, more thoroughness is needed. The pattern of instruction in the grades and in high school has undergone some very radical changes in the past 20 years. This change in pattern has taken place in recognition of the fact that the majority of high school graduates do not go to college. The result has been a marked increase in and emphasis on general cultural and vocational subjects with correspondingly less emphasis on the college preparatory aspects. There is no question but what this change of pattern has redounded to the advantage of a great many boys and girls. But it has, at the same time, given us high school graduates less capable of carrying university work, particularly in a specialized field such as chemistry.

The relaxing of emphasis on mathematics in high school reflects itself in the increasing difficulty that students have with arithmetical problems. More and more time must be spent explaining and discussing these problems. The changing pattern of grade and high school instruction reflects itself in decreased disciplining in good hard work. Too many students have no idea what it means to really get down and study hard. As a result, when they are given an assignment which is expected and intended to require two hours of good hard effort they spend half an hour or an hour on it, decide that since they never spent more than half an hour on any assignment before that that is enough for this one and let it go at that. After four or five weeks of this they find themselves completely lost in the course.

What can be done to help solve these problems of elementary science teaching? To help answer that question let's ask some more questions. Shall we continue to stick to the time-honored tradition of twelve years of elementary and secondary schooling and four years of college or shall we suggest an additional year of high school or an additional year of college or both? Shall the time-credit dimensions of the elementary course remain fixed at their present value or shall they be increased as the dimensions of the particular science increase? Shall we, in universities and colleges, continue to take over tasks formerly done by the high schools, as we surely have been doing in the past several years, or shall we ask that the high schools take back what previously belonged to them? Shall we, in college and university, insist that the students come up to standards that we set or shall we adjust our standards to meet the new trends in secondary education? Is it desirable to seek greater uniformity of standards in each particular science, both as to quality and content, among all colleges and among all high schools?

If we set as the objective of general education the acquisition of a certain per cent of the world's store of

(Continued on Page 114)

The Palomar Giant Has a Little Brother

• **By Wyn Davis**
PUBLIC RELATIONS DEPARTMENT, BUHL PLANETARIUM, PITTSBURGH, PENNSYLVANIA

Here is an account of a small scale model of the Palomar telescope made by an amateur astronomer. His patience, skill, ingenuity, and determination resulted in an instrument that engages the interest and excites the admiration of all who see it.

There are some amusing side lights in this story.

●

June 3, 1948 will go down in history.

Not history of wars, of political campaigns, of domestic, national, or international complexities which occupy our lives today, but history of man's relationship to the vast universe which surrounds his planet, Earth, and of which he is such an integral part. It may even go down in the history of life itself!

On this date the "most daring optical job ever attempted by man," and one of the greatest constructional, mechanical, and engineering feats of all time was opened to the public, completed except for some minor adjustments.

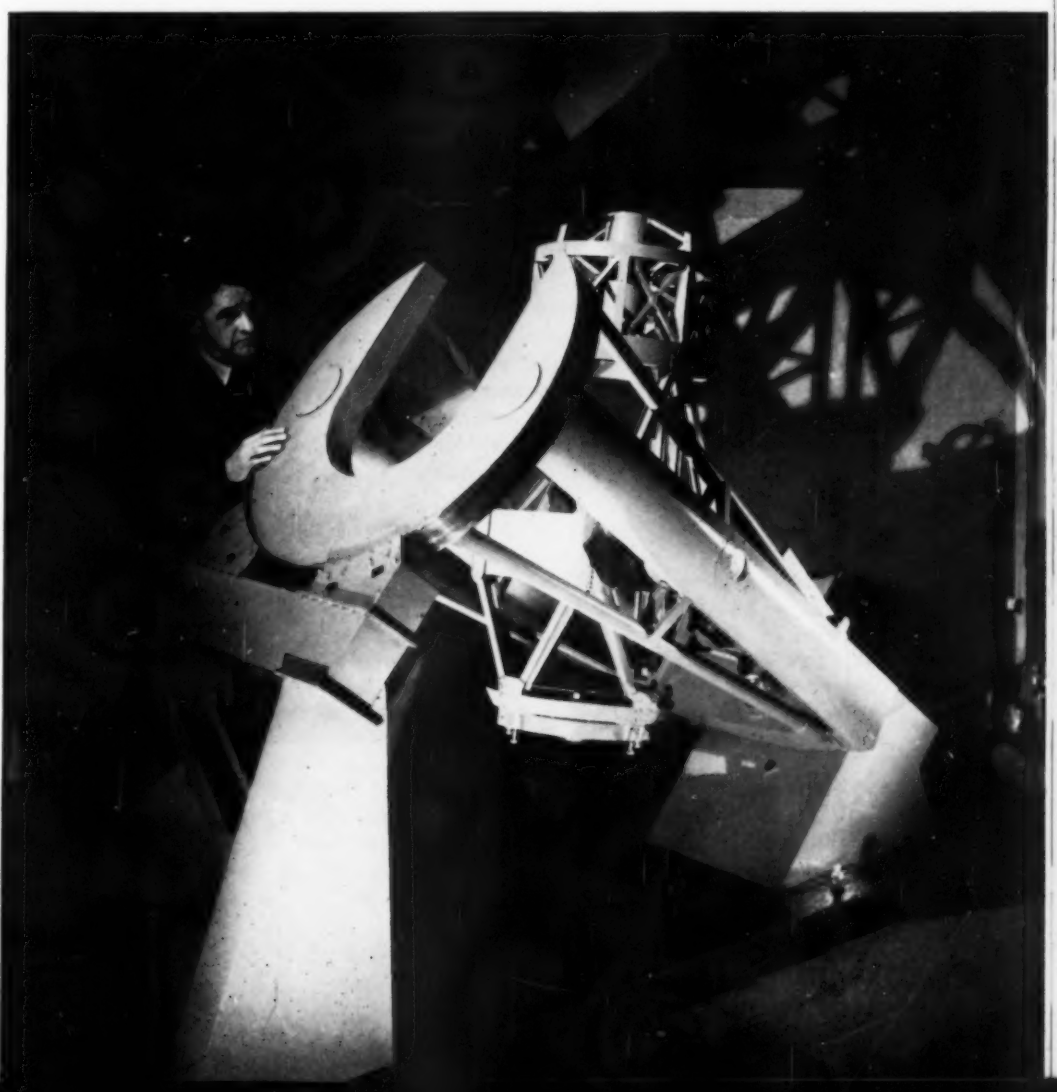
Over 1,000 people watched Mrs. George Ellery Hale christen the 200-inch giant—the largest precision instrument ever devised—the "Hale" telescope after her famous husband. Dr. Hale not only fathered the fund-raising and construction planning of this huge telescope until death stopped him in 1938, but he also founded the Yerkes Observatory of the University of Chicago, and the Mount Wilson and Palomar Mountain Observatories.

Dr. Hale conceived the "Big Eye," as the newspapers fondly dubbed it, about 20 years ago. Everyone seemed a little surprised when he petitioned for and was granted $6 million from the Rockefeller Foundation for the creation and installation of a telescope twice as large as the 100-incher on Mount Wilson.

It wasn't until 1936, eight years after the funds were granted, that the actual work of grinding and polishing the huge 200-inch mirror could begin. The successful casting of this 20-ton "wafer" on December 2, 1934 was accomplished after many previous failures.

In 1929, experiments were started by the General Electric Company in Lynn, Mass., with large fused quartz disks. The first 60-inch disk cracked, and during the ladling of the second one, a fragment of furnace brick dropped into the molten mass, ruining it completely. An attempt to repair the first disk came close to success, but somehow the electric current was turned off in the process and the crack widened until the disk was wrecked. By that time $600,000 had been spent, so the Pasadena astronomers decided their only hope was

CLIFFORD RAIBLE exhibits his working model of the Palomar telescope. One sixteenth actual size, it is built of alloyed materials which Mr. Raible cast in his cellar workshop. He was once a student under the famous Pittsburgh astronomer Dr. John A. Brashear. (Photo courtesy *The Pittsburgh Press.*)



the super-Pyrex glass manufactured by the Corning Glass Company in Corning, N. Y.

After several trials with smaller disks had proved successful, a 200-inch disk was cast, but proved to be a failure when several cores from the mould were found adhered to the bottom. Months later, a second 200-incher was cast. It was found perfect in every detail. For almost a year the technicians waited in apprehension while the huge eye cooled. Then in 1936, it was moved to the California Institute of Technology, where Marcus H. Brown and 21 "men in white" waited to begin grinding and polishing the 20-ton disk down to 2 millionths of an inch perfection. This nerve-wracking job, which reduced the disk to a "mere" 14½ tons, took them 11½ years, except for the war interim of four years.

Construction of the giant dome, the work camp, main residence, plants, machine shops, power-houses, and other buildings needed for the operation of this telescope got under way in 1935. Covering an area of around 1,960 acres, these buildings will house not only the giant telescope and all the equipment necessary for its maintenance, but also some of the country's greatest astronomers will reside on the grounds to be close by for astronomical research and observation.

The dome of the observatory, which is made of steel, is as high as a 12-story building, has a diameter of 137 feet, and weighs over 1000 tons. Yet it is easily controlled by a 25 horsepower motor which rotates it on 32 four-wheel trucks on a circular track. Even the telescope is a ponderous mechanism, weighing 530 tons; but it, too, swings east or west, north or south, by a little electric motor of only 1/10 of one horsepower.

During the long years of planning and constructing the Palomar giant, a certain individual who was an amateur astronomer and telescope maker of long standing decided to build his own "Big Eye." He was Cliff E. Raible, of Millvale, Pa.

At the very beginning, when plans for the 200-inch were proposed, pictures of the fork-type mounting, which had been suggested by the Pasadena astronomers and which was similar to that of the 60-inch reflector at Mount Wilson, appeared in an early edition of *Men, Mirrors, and Stars*, by G. Edward Pendray. These pictures caught the spark of Mr. Raible's interest in the proposed giant, and fanned it to the white heat of action which started the long, tedious construction of his model. His first was built to a scale of 1/25 actual size. The tube, fork, and base were made of aluminum, molded and cast by Raible who used his home-heating furnace with a forced draft to melt the aluminum. Hundreds of hours of spare time were required to complete this model, which was displayed during the convention in Pittsburgh in 1940.

Unfortunately for Cliff, "The Astronomers" decided against the fork mounting, and adopted the yoke with a horseshoe journal as the north bearing. Since Cliff's model was intended to be authentic, there was nothing for him to do but start all over again.

Early in 1939, equipped with excellent information of the original construction plans given him by influential friends, Cliff decided on an accurate 1/16 scale model.

Materials of every description began to accumulate in the rug-sized workshop in Millvale. Aluminum, in huge stacks, crammed one corner, and an 11-inch screw-cutting lathe, a half-inch drill press, numerous patterns, copes, drags, and bushels of molding sand cluttered the floor.

The amateur astronomer became a familiar sight to the workers at the Westinghouse East Pittsburgh works, where the north bearing for the "Big Eye" was being fabricated. Talks with the workers and the many hours spent in watching the operation paid dividends to Cliff when the horseshoe journal bearing and its mating pads for his model were made later. This was probably the most difficult part of the model to construct. The outside diameter of the horseshoe is 34 inches, its face 3 3/16 inches high. Fabricated of steel sheets welded together to form at first a complete circular bearing, its 160 pounds made it difficult to handle alone, and Mrs. Raible was "drafted" frequently to assist in moving it.

Work was delayed for some time until a brand new 45-inch mill was located, sufficiently accurate to machine the outside of the journal bearing. Arrangements were made to permit Raible to surface his bearing on the new mill for its maiden effort. After the throat of the horseshoe was cut out of the machined perimeter, the strain released was so slight as to alter the dimensions of the bearing by less than 0.002 inch, thanks to the excellent condition of the mill and a fine annealing after fabrication.

A 3½ year tour in the U. S. Navy during the war caused another delay, but Cliff acquired much valuable training which helped materially in the later work on the model.

The telescope model was first exhibited publicly in the Hall of Astronomy at the Buhl Planetarium and Institute of Popular Science, Pittsburgh, during a meeting of the Amateur Astronomers Association of Pittsburgh, October 10, 1947. Since it was so popular an attraction to the Planetarium's daily visitors, the Planetarium administrative staff persuaded Mr. Raible to place his model on permanent exhibit in the Hall of Astronomy. Thousands of people have viewed this intricate mechanism, and have wondered at the patience, skill, and ingenuity that Cliff possessed to construct such a perfect "little brother" to the Palomar giant.

Mr. Raible's model contains a 12½ inch pyrex mirror, 22½ inches focal length, with a 4-inch pyrex secondary, and auxiliary flats to enable the secondary focus to be formed at the lower end of the south polar bearing. Also, a secondary focus can be formed at either extremity of the declination-axis tubes, where eyepiece sockets are arranged. Photographs can be secured at the prime focus by removing the Cassegrainian secondary mirror and inserting a plate-holder in the prime-focus cage, but in

(*Continued on Page 116*)

Margarine—Cinderella of the Food Field

• **By Harold B. Reed**
GENERAL SALES MANAGER, PACKAGE FOOD DIVISION, THE CUDAHY PACKING CO., CHICAGO, ILLINOIS

Everyone who reads newspapers knows about the recent Congressional campaign for and against margarine. Not everyone knows how this once disdained food is made and tested. Here is an up to the minute description by an expert.

No longer is margarine a "Cinderella." A delicious, wholesome, nutritious food, it is praised by consumers and experts and served and enjoyed in the homes of millions of Americans.

●

Origin of Margarine

In a recent magazine cartoon a little calf was pictured looking inquisitively at its mother. The mother cow had turned to her husband and, obviously exasperated, was saying, "Now she wants to know where margarine comes from!"

Although the origin of margarine may be a mystery to the cow, the facts about it are well-known. Margarine had its beginning during the Franco-Prussian War when France was faced with an acute shortage of edible fats and oils. Napoleon III offered a large cash prize to anyone who could develop a satisfactory substitute for butter. The prize-winner was a French chemist named Mege-Mouriez.

This chemist had actually tried to produce butter itself through a series of laboratory treatments, converting animal fat into milk fat, as in the function of the animal itself. He prepared his product from beef fat, digested with pepsin, casein, udder extract, and sodium bicarbonate.

The concoction which the Frenchman made in 1860 was anything but appealing. In spite of this, during the next five years the manufacture and use of the new product, which came to be called margarine, spread from France to England, Holland, Germany and the United States.

Important Processing Developments

As the use of margarine increased, it was steadily improved by advances in research and processing methods. A major change came when instead of animal fats vegetable oils could be used as a basic ingredient. This was made possible by the development of two new processes. One was a method of refining vegetable oils. It was a process that removed the unpleasant taste and odor found in the natural oils. The second was hydrogenation. This new process raised the melting point of the oils and produced a semi-solid product that remained firm at ordinary temperatures.

A big advantage of vegetable oils is their abundance and availability in this country. That is why the margarine industry today is such a big user of America's cottonseed and soybean oils.

At the time of these basic product developments, techniques were also being developed to perfect the taste and nutrition of margarine, thus making it a completely satisfying, pleasing and nourishing spread for bread.

How Modern Margarine is Made

The step-by-step production of a top quality, modern margarine begins with the seeds from which the oil is taken. At Cudahy we use the highest quality cotton seeds, selected according to definite specifications. These are pressed to release the rich, natural oil. All oils used are treated in our own refineries and must meet very high standards. Thus, we keep absolute control over the quality of oil used in our product.

After the refined oil is drawn off in a separation process, it is bleached and becomes crystal clear.

The next step is hydrogenation, in which the clear liquid oil is converted to a semi-solid fat. This fat is then completely deodorized so that every hint of the natural oil flavor is removed. Now it is ready for margarine. Up to this point, the oil must meet ten rigid specifications that we have set up for top quality.

The hydrogenated oils are as flavorless and odorless as pure water. Fine flavor is achieved by adding fresh, cultured skim milk. The milk is pasteurized and carefully cultured to produce a delicate lacteal flavor and aroma.

This pasteurized, cultured milk is then churned with the basic oil. To this mixture is added a small amount of salt, preservative, an emulsifying agent which improves the pan-frying quality, and a substantial reinforcement of Vitamin A, enriching each pound with a minimum of 15,000 U.S.P. units.

The mixture at this stage is emulsified but not permanently "fixed." Further hardening is necessary. Therefore, it must go through processes of chilling and crystallizing before packaging.

Margarine Coloring Problem is Solved

At this point, our procedure at Cudahy differs from that of most other margarine makers. The difference is due to our new, special package which is an outstanding development in modern margarine. It has solved the housewife's margarine coloring problem.

For years the messiness, waste and bother of coloring margarine in a mixing bowl has retarded the use of the product. Cudahy was the first to eliminate this handicap

(*Continued on Page 109*)

A River in the Sea

• **By Richard H. Fleming, Ph.D.** *(University of California)*
CHIEF, DIVISION OF OCEANOGRAPHY, UNITED STATES HYDROGRAPHIC OFFICE, WASHINGTON, D. C.

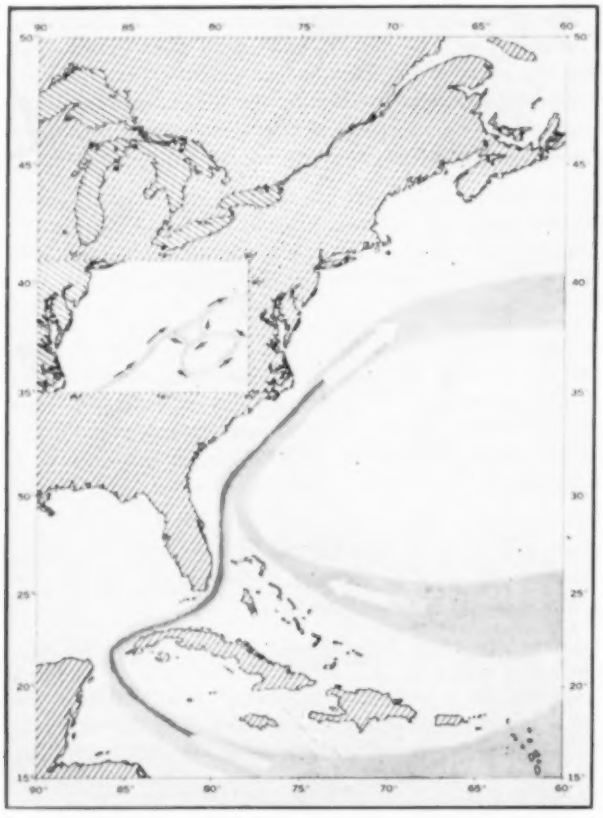
Only recently have we learned that our long-held concepts of the nature of the Gulf Stream are incorrect. They were based on inadequate data.

Now we have a clearer understanding of the nature and direction and speed of this great river without banks. This has been made possible by the numerous observations made by the exploring ship Atlantis of the Woods Hole Oceanographic Institute which used Loran to fix its position accurately as frequently as desired.

Here is a description of the "new" Gulf Stream.

●

"There is a river in the ocean: in the severest droughts it never fails, and in the mightiest flood it never overflows; its banks and its bottoms are of cold water, while its current is of warm; the Gulf of Mexico is its fountain, and its mouth is in the Arctic seas." With these words Lieutenant Matthew F. Maury, U.S.N., began the chapter on the Gulf Stream in his *Physical Geography of the Sea*, the book whose publication in 1855 created the science of oceanography. Maury was not, however, the first scientist to describe the Gulf Stream. That had been done in 1770 by Benjamin Franklin, using data obtained from Nantucket whaling captains.



THE AVERAGE COURSE OF THE GULF STREAM, as derived from ship current observations in the Hydrographic Office. The heavier shaded area is approximately the region of maximum flow, as found by this method. Inset is the actual current distribution observed by the *Atlantis* on July 1 to July 4, 1947, using Loran for accurate frequent position determination.

The earliest descriptions of the Gulf Stream recognized that off the coast of the United States, near shore from Florida to Cape Hatteras, and farther offshore to the northward, there was a current of warm water, without counterpart elsewhere in the North Atlantic, which flowed in a generally northeasterly direction with a speed sufficient to lengthen by two weeks the voyage from Europe to New York of a sailing vessel unwary enough to lay her course through the region of maximum flow. Likewise it was recognized that the warm current carried great quantities of tropic heat to higher latitudes. Off the United States, this was manifested by the weather effects encountered crossing the Stream, such as thunderstorms and choppy seas—"if Bermuda lets you pass, then watch out for Hatteras"—went the adage—but to the same cause were also attributed the fogs of the Grand Banks, the green fields of Ireland, the wet climate of the west of Norway, and even the freedom from ice enjoyed by the Murmansk coast of Russia.

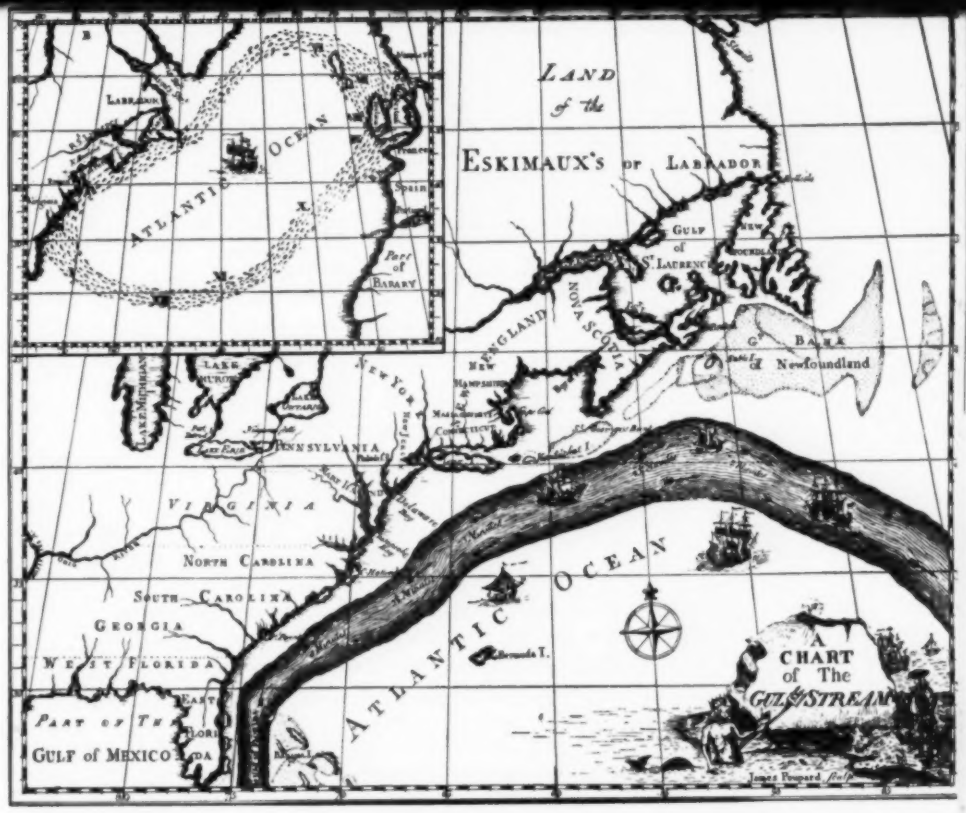
Under Maury's direction, Lieut. Bache was detailed in a small naval vessel to explore the Gulf Stream, and he found that although there were frequent alterations of water temperature experienced in crossing it, there was characteristically a zone of relatively cold water just inshore, which he christened the Cold Wall. Later another naval officer, Lieut. J. E. Pillsbury, while serving with the Coast and Geodetic Survey, made extensive current measurements along the Gulf Stream, the results of which were published in 1891.

More recently, Dr. Columbus O'D. Iselin of the Woods Hole Oceanographic Institution has divided the current into three sections. From the Straits of Florida, between Florida and Cuba and the Bahamas, to Cape Hatteras, the current follows the edge of the continental slope, and is designated the Florida Current. From Cape Hatteras to the Grand Banks, the name Gulf Stream is retained, while to the eastward of the Grand Banks, the flow is very much branched and subject to eddies, and is known as the North Atlantic Current.

The Florida Current originates in water that has been driven by the trade winds south of Puerto Rico, Hispaniola, and Cuba into the Yucatan Channel between Mexico and Cuba. Most of this water escapes through

the Straits of Florida without entering the Gulf of Mexico, so that the term "Gulf Stream" is somewhat of a misnomer. North of the Bahamas the Florida Current is augmented by the Antilles Current, which brings water from the region of the Sargasso Sea and with it the floating sargassum or "gulf weed" that is characteristic of the Gulf Stream.

It is only within the last two years that a technique for accurately measuring and locating the maximum current velocity of the Gulf Stream has been perfected. For over one hundred years the Hydrographic Office has collected and analyzed current records from ships at sea. These determinations are made by fixing the ship's position accurately, proceeding for a time on a known course and speed, making a second accurate position determination, and comparing the position arrived at with that predicted from the course and speed in the absence of any current. Until recently a ship's position at sea could be determined with sufficient accuracy only just before sunrise and just after sunset, when several stars and the horizon were all visible. This meant that any current encountered was averaged over a 12-hour run, and any narrow belt of relatively high velocity was undetectable.



BENJAMIN FRANKLIN'S CHART OF THE GULF STREAM, from the Transactions of the America Philosophical Society, 1786. Current speeds are indicated in minutes of latitude (nautical miles per hour.

The war-time development of Loran, however, permits an accurate position fix for a vessel at any time. Using Loran in 1946, the research vessel *Atlantis* of Woods Hole Oceanographic Institution was able to locate the regions of maximum current flow of the Gulf Stream and determine its speed and direction. The results showed that the speed was much higher than had previously been assumed, reaching maximum values of five knots over distances of about five miles. Figures of nearly this value are to be found in the files of the Hydrographic Office, but most ships reporting had run out of the high current zone in an hour or two, and the average current reported for 12-hour periods was only one and a half or two knots. The results of the *Atlantis* on the position of the zone of maximum current speed and of its direction, were likewise not in agreement with older theories, for the Stream was found to be subject to continual meandering, with large eddies breaking off and flowing alongside the main current, so that a vessel might encounter several different changes of direction within a few miles. These observations give a picture of the current considerably different from the older data, which yielded an average value of the drift satisfactory for navigational purposes, but which obscured the finer details of its behavior. Maury's river in the sea, unconfined by banks other than adjacent colder water, is now seen to form bends and cut-offs just like a land river.

Why is there the Gulf Stream on the western side of the Atlantic and no similar current on the eastern side? An examination of the other oceans indicates that it is a common property of all oceans to have a well-developed warm current on the western edge, flowing away from the Equator. The North Pacific has the Japan Current, the South Atlantic has the Brazil Current, the Indian Ocean has the Agulhas Current, and the South Pacific has the East Australian Current. Mr. Henry Stommel of the Woods Hole Oceanographic Institution has recently shown by a complex mathematical analysis that this characteristic flow on the western side of an ocean, away from the Equator, is a necessary result of the combination of Coriolis force, the distribution of density in the sea, and the prevailing westerly winds of the temperate zones.

These theories must be tested by observations at sea, however, for a full understanding of the causes and characteristics of ocean currents is still far from attainment. Oceanography, in spite of the progress that has been made since the time of Maury, still has a multitude of unsolved problems. ●

★ ★ ★ ★ ★

"Scientists, having more opportunity than most humans to observe the marvels of matter, and with minds trained to clearer logic in classifying the results of reasoning, are among the most truly reverent of mankind."

HANOR A. WEBB

Peabody Journal of Education

The Distribution of Certain Trees Rare to Southwestern Pennsylvania

• By Paul R. Stewart

PRESIDENT, WAYNESBURG COLLEGE, WAYNESBURG, PENNSYLVANIA

This paper points out that at times the distribution of trees is difficult to explain, certain trees rare to a region occasionally appearing most unexpectedly. Sometimes by on-the-spot study investigators are able to provide a satisfactory solution.

President Stewart, a distinguished botanist, shows here how scientific information is assembled by trained workers. Teachers with wide experience in the field will agree that valuable botanical information can be gained by enlisting the interest and aid of alert college and high school students.

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Kentucky Coffee Tree
Gymnocladus dioicus

The Kentucky Coffee Tree, sometimes known as northern mahogany, has been proclaimed from time to time by Pennsylvania botanists and foresters and other writers as not occurring in Pennsylvania. Dr. Thomas C. Porter's records state that he had observed this species on Conococheague Creek in Franklin County, Pennsylvania.[1] Sargent, probably taking Porter as a reference, makes the statement that the tree is found in "western New York and Franklin County, Pennsylvania."[2] Illick, in his *Pennsylvania Trees*,[3] states that he traveled along this creek from its headwaters in the South and North Mountains to the point where it empties into the Potomac without finding a single specimen.

In the year 1934-35, the author, feeling that the southern range of the Kentucky coffee tree might make it possible for the waters of the Monongahela to bear propagules of the plant to locations more northern, began the search for this species. He made use of members of his various botany classes with the result that in 1935 an assistant, Ben Donley, now with the State Fishery at Bellefonte, discovered a nature student in the region of Carmichaels, Pennsylvania, by the name of Jeff Stone, who claimed to have found a specimen growing near Brown's Ferry on the Monongahela, just east of Carmichaels. An expedition proved the validity of Mr. Stone's statement. A specimen with multiple trunk was found near the water's edge a few hundred yards below the ferry. The various units of the trunk were, in the estimation of the author, in the neighborhood of fifty years old; and it is probable that these trunks arose from removal of an original trunk by possible cutting or breaking in some flood. This interpretation would throw the age of the original tree back to such a time as would make the planting of a tree by residents of the region highly improbable.

The publicity given to this find led to the announcement by Dr. Louis F. Arensburg, of Arensburg's Ferry, on the opposite side of the river from Crucible, Pennsylvania, that he had a number of specimens on the old Arensburg farm upon which he then resided. Dr. Arensburg at that time was ninety-three years old. He directed us to the old Arensburg house, then in ruins, around which in a quadrangle were a number of large Kentucky coffee trees. Dr. Arensburg claimed that when he was a mere boy his father had purchased this farm from an old German, and that the German had secured the trees from a short distance down the river, selecting small trees from near some very large ones. The doctor further stated that these large trees had been felled when the railroad made a cut along the bank. Knowing the persistence of the species in its natural habitat, the author felt that possibly sprouts would survive. He and his party forthwith went to the place indicated by Dr. Arensburg and there found a number of saplings which were persistently attempting to grow along the railroad cuts and fills in spite of the fact that they had been often cut away in the maintenance of the right of way.

In view of all these facts we conclude that the original trees growing along the banks of the Monongahela River could scarcely have been brought in by pioneer settlers. Dr. Arensburg's boyhood would be synchronous with the middle of the nineteenth century and large trees would probably be old enough to carry the time of their propagation from seeds back towards the French and Indian War and the very earliest settlers.

There is this added thought: even had these earliest settlers brought a few seeds and saplings, they would not have chosen the steep bank for setting them out.

We conclude from these two discoveries that the species, *Gymnocladus dioicus*, is native to southwestern Pennsylvania on both the Greene County and the Fayette County banks of the Monongahela River.

Post Oak
Quercus stellata

This oak is a species of southern and southwestern range. The author has observed it growing in southern Ohio, Indiana, Illinois, Kentucky, Tennessee, and Missouri. In Kentucky and Tennessee, where it becomes numerous, it is found in quite large pure stands. It also occurs along the Atlantic coast as far north as Massachusetts. It is found as far south as Florida, and

(*Continued on Page 112*)

Science and the National Welfare

• **By E. U. Condon, Ph.D.** *(University of California)*
DIRECTOR, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

Perhaps better than anyone else the Director of the National Bureau of Standards appreciates the importance of science in promoting the safety and welfare of our nation.

In an address delivered in Washington not long ago before the American Council of Commercial Laboratories, he discussed the question in some detail.

The address is presented here for the thoughtful consideration of science teachers, who can do much to help form public opinion on questions in which science is concerned.

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Society is at this moment at the threshold of an undreamed of mastery of our material environment, for science, which provides that mastery, is in its Golden Age.

In particular, achievements in nuclear physics promise incredible advances in the years ahead. Energy from atomic power plants has been much talked about, but even more important are the tools provided by nuclear physics for research in other fields. Radioactive isotopes, for example, will permit us to explore the structures and constitution of molecular aggregates, for such isotopes can be introduced into a system as scientific detectives. They will behave as the usual atoms of the particular element behave, but they can be traced and studied by means of the radiation they emit. Tracer studies of this kind will unravel secrets in biology, physiology, medicine, chemistry, and metallurgy.

The combined effect of tracer studies, of a variety of sources of radiation, of various sources of high-intensity highly-accelerated sub-atomic particles, and fundamental knowledge of the nucleus means that spectacular advances in many fields are at hand. The problem of curing fatal diseases will be successfully attacked; fundamental biological and physiological processes will be understood; new types of therapy will be developed in medicine; better control of intricate chemical manufacturing processes will be feasible; new products, like petroleum fuels and metals with unusual properties, will be possible; and even new forms of plant life can be created. The speed with which these possibilities are realized depends primarily on how much effort we put into such activities. For there is no question that the impetus of the new knowledge in nuclear physics, in conjunction with steady advances in other fields of science during the last 50 years, means a general efflorescence of the physical and life sciences.

But if we are to profit from this happy situation, there are major problems to be solved, and their solution will not wait. From one point of view life today is a race, a race between knowledge in the physical sciences which gives material mastery, and general ignorance which retards or rejects mastery of our environment. Rejection means no more and no less than destruction of civilization as we know and cherish it.

The problems confronting us, approaching them from the standpoint of the sciences, exist on several planes: —two in particular: the specific problems of science as science and the question of these sciences in relation to the other activities of man.

Problems of Science

The problems arising within the sciences themselves are extremely practical ones, and on the whole they are not complex. Several axioms are at once apparent. First, science is universal. Second, science is unlimited in its material. Third, the rate of scientific progress depends on the amount of effort put into science. These axioms are important: they mean that no individual and no nation has a monopoly in science, that science affords an inexhaustible mine of valuable knowledge and discoveries, and that we must be willing to support science appreciably if we expect to gain heavily and to maintain leadership.

The Steelman Report

A comprehensive and cogent analysis of the problems of science is to be found in Dr. John R. Steelman's report to the President, *Science and Public Policy*. Taking into account the three major groups in research and development activities—the universities, the industrial laboratories, and the Federal research agencies—Dr. Steelman points out that each of these groups is "especially adapted to the performance of a particular type of research and each can make a unique contribution to our total research and development effort," with university emphasis on basic research, industry on development, and Government laboratories engaged in both.

As a "basis for our progress against poverty and disease" and as the basis of national security, the Steelman report analyzes the present scope of our scientific effort, the deficiencies now present, and the needs in terms of a broad program. The main recommendations of the Steelman report are eight in number, and I would like to discuss them briefly.

1. It is recommended that expenditures for research and development be expanded as rapidly as facilities and trained manpower can be provided. A suggested goal is that by 1957, 1 per cent of the national income should be expended in research and development in university, industry, and government laboratories.

The report shows that a little over 1.1 billions are being spent this year for research and development,

excluding the social sciences. With a national income of 200 billion dollars, this is an expenditure of little more than ½ per cent. Only about 110 millions, or less than 10 per cent of the total, is spent for basic research. Almost half—that is 460 millions—enters into the development of military weapons and needs, not including the amount spent for atomic bomb development now considered to be a civilian activity.

2. It is recommended that heavier emphasis be placed in the future on basic research and on medical research. More specifically, it is recommended that the total research and development budget be doubled, coincidentally quadrupling basic research activity and tripling research on health and medicine.

3. It is recommended that support for basic research be provided for the Federal Government at a progressively increasing rate, reaching an annual rate of 250 millions by 1957. The present rate of total expenditures for basic research is 110 millions while quadrupling would require 440 millions; so that this proposal leaves ample scope for large scale and expanding support of basic research by private groups and state governments.

4. It is recommended that a National Science Foundation be established with a Director appointed by and responsible to the President to administer the program of grants in support of basic research. It is also recommended that the Director have a board of advisors half of whose members should come from Government laboratories in order to provide for proper correlation of the work with that of the Government laboratories.

5. It is recommended that a program of Federal scholarship aid to university students be developed in order to provide for the proper training of the increased number of scientists needed and that this program be a part of a general program of assistance to university students in all fields of interest.

6. It is recommended that suitable Federal assistance be given to colleges and universities in developing their scientific research facilities and that this should be administered as part of a broad program of aid to universities in all fields.

7. It is recommended that the work of the several Federal research establishments be better coordinated by the establishment of an Interdepartmental Science Committee, by a coordination of all scientific research programs through the Bureau of the Budget, and by the assignment of a member of the White House staff to devote himself to problems of liaison at the top policy level of the Federal Government.

8. Lastly, it is recommended that aid to the reconstruction of European scientific research be made part of our European Recovery Program. This recognizes, first, that science is universal in that its truths are part of the universe accessible to all investigators; second, that we gain as much by original discoveries made elsewhere as by those which we make; and, third, that the progress of other nations in science and technology is necessary if they are to become self-sufficient again.

The program outlined in the Steelman report is splendidly conceived, and every point is vital if we are to live up to the responsibilities with which we are confronted by our good fortune in natural resources and freedom from war devastation.

One of the great difficulties about a major program of expenditures on basic research is that it is so difficult to explain to an appropriations committee—and even to management in private business—precisely what the program will accomplish with that degree of definiteness expected and demanded in other fields. It is necessary to entrust funds for research programs on faith, on the competence of the leaders of such programs, and the trust must be maintained for a sustained period of time. It is characteristic of most fundamental research that several years are required for the completion of any work of importance and that the end result may be difficult to evaluate by anyone except specialists. What, for example, is the cash value of Einstein's discovery of the relation $E = mc^2$? No doubt it is an astronomically large value now. But what was its worth at the time of its formulation? And who was qualified to make the evaluation? The point simply is this: pure knowledge can not be evaluated in cold cash, and pure knowledge is independent of such evaluations.

Unfortunately, appreciation of this fact is not as widespread as it should be, which suggests the story of two partners who had long operated a chemical manufacturing business. They finally decided to employ a research chemist. Along about 11 A. M. of the first day of his employment, one partner said to the other, "Shall we go see whether that research chap has discovered anything? . . "No," replied his partner, "It's a little too soon. Let's wait until after lunch."

Zones of Danger and Weakness

One of the dangers facing us in the present situation is overconfidence. The United States has led the world in technological progressiveness and in the techniques of mass production. We are, without question, the most powerful nation in the world. In these very facts lies the essential danger, for over-confidence is a product of precisely this set of circumstances. Illustrations of pride preceding fall fill the pages of history, and civilization after civilization has perished in this fashion. We need glance backward no farther than the recent war to see a once scientifically sophisticated power lose leadership and initiative: Germany. For many years, during the latter half of the 19th Century and the early 20th, science in Germany was in a position of international prominence, and yet we now know how misguided and superficial were their efforts in the direction of atomic energy. I believe that two factors were at play here: First, the Nazi leaders eliminated the truly first-rate scientific leaders and installed second-rate party-men in positions of scientific leadership.

Second, there are obvious evidences of overconfidence on the part of the scientists as well as the nation in their scientific ability and achievement. Thus, after the revelation of our work in atomic energy, we had the spectacle of, first, the German refusal to believe that accomplishment, and second, childish attempts to pretend that they had not wanted to develop an atomic bomb but that they really had progressed in atomic research and that their researches were to be devoted to peacetime uses. The rationalizations would be merely amusing were they not also sardonic.

Again, we have the spectacle of England's dilemma in this century. Prior to the 20th century, the English had led the world in technology, one of the consequences of their early industrialization. This leadership had lulled the British into accepting this preeminence almost as a law of nature, and progress in modernization of facilities and in massproduction technique was not pursued vigorously. The result was that England fell behind Germany and the United States. A reluctance to accept scientific advances, in the face of obsolescence, is thus dangerous.

The obvious lessons of the past, as far as science is concerned, indicate that competent leadership must be fostered in science—remember that for every thousand scientists adequate to contribute in a rather routine way there is only one with great and inspiring creative ability—and we must never take for granted future achievements on the basis of past performances. This thought leads to another danger confronting us: as a nation we have been outstanding in applying science; we have not been outstanding in basic scientific discoveries or theory. If we are to attain our goals, it is imperative that basic research be supported on a large scale.

In atomic energy, for example, we were essentially dependent upon the work of European scientists for our basic knowledge, and European scientists in this country contributed heavily to our success, in particular Fermi and Szilard. Again, during the first half of the war, we were dependent on British research and development in radar for our own program, and it was not until the latter portion of the war that we contributed in a basic way to this field. Then our contributions, particularly in microwaves, were significant.

Research in Rubber

Still another field, vital to our economy, in which we have been dependent on European research is rubber, representing in the recent conflict a vast Federal investment second only to atomic energy and radar. The need for synthetic rubber during the war, as a result of the unavailability of natural rubber, is well known. What is not so well known is that the synthetic rubbers we used were developed largely by the Germans. The four types of synthetic rubber which we produced during the war were GR-S, Neoprene, Butyl, and the Nitrile rubbers. Of these only Neoprene is purely American, a development of the DuPont Company. Butyl is partially an American development, for it constitutes a radical improvement of the German material polyisobutylene, yet it was based on this German work. Fundamental patents were taken by the Germans on the remaining two types—the Nitriles (under the German name Buna-N) and GR-S (under the German name Buna-S)—in the early 30's. Of all these rubbers, GR-S is the most important: more than 80 per cent of our total production was of this type because it is not only cheaper but best for tires.

Now that natural rubbers are again available, the problem of what to do with the synthetic industry, which involved a Federal investment of more than $700,000,000 is acute. This industry will be called on for only limited production, primarily to insure plant potentialities in the event of any future emergency and to provide the synthetic product for certain applications. The magnitude of the investment, the size and scope of the plants, and the relations between the synthetic and natural commodity are major commercial problems. For this very reason, the need for continued research and development is obscured.

The National Bureau of Standards has long been active in the research and development phases, both as they pertain to synthetic rubbers and natural rubbers. From the standpoint of the national economy and security, it is necessary that a major and coordinated program of research and development be maintained in this field. Basic research is necessary if new types of synthetic rubbers are to be developed; developmental research is needed to develop desirable characteristics in the rubbers now available, to determine their properties. Much also remains to be done in measurements and instrumentation associated with the synthetic rubbers.

In the future this country must have a vigorous program of rubber research to maintain "a technologically advanced and rapidly expandible domestic rubber-producing industry" as part of our national policy outlined in the Crawford Act (Public Law 24, 80th Congress.) The cost of such a program would involve an annual expenditure of about 4 million dollars, which is less than 1 per cent of the amount spent for the 1 million tons of rubber that this country consumes annually. Industry should expend a corresponding amount for the development of new rubbers, in addition to its expenditures for research on end-products.

The cost of such a program is really relatively small in terms of the value of the commodity and in terms of its national importance. Merely to maintain the present synthetic plants in a stand-by condition involves an annual expenditure of over 8 million dollars, and these plants may well be obsolete at the time of another emergency; so that a federal expenditure of half this, to insure our future in this field, is, from any practical point of view, trifling.

Research in Optical Glass

A comprehensive and broad program of research in

(*Continued on Page 103*)

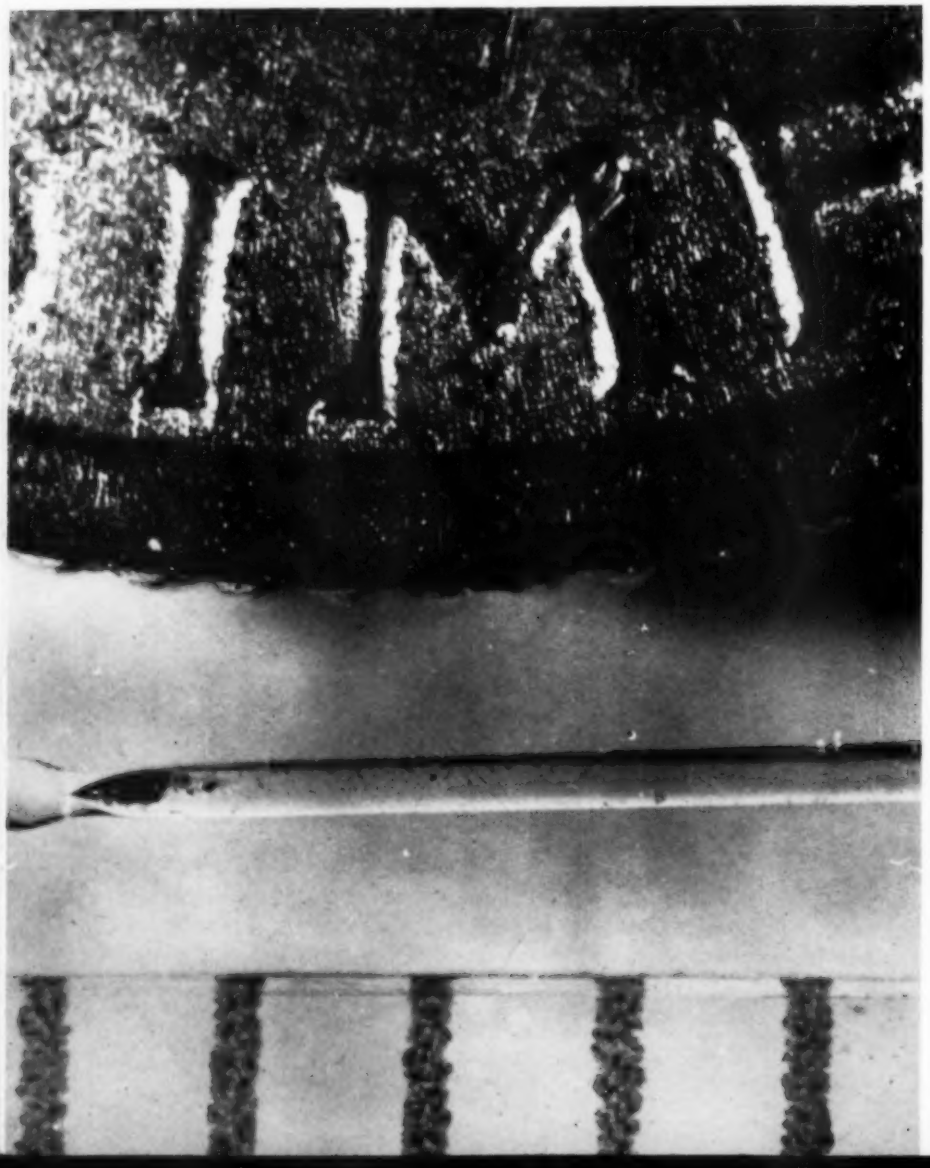
The Transuranium Elements

• By Ralph A. James
FORMERLY, DEPARTMENT OF CHEMISTRY AND RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY. NOW, DEPARTMENT OF CHEMISTRY, UNIVERSITY OF CALIFORNIA AT LOS ANGELES

For 150 years chemists believed—without sufficient reason as they now know—that no element heavier than uranium would ever be found. But within the last decade four elements of higher atomic number have been produced artificially.

The center for this research has been the laboratories of the institution with which the writer of this article has been connected. He has been actively engaged in the work. Here he gives a first-hand account of the new elements, and the change in the Periodic Table made necessary by their discovery. You will be interested to learn how their names were selected.

TEN MICROGRAMS OF PURE NEPTUNIUM OXIDE at bottom of Capillary Tube (magnified about 40-fold). Below the sample, for purposes of comparison, is a millimeter scale, and above is a U. S. 10 cent piece.



Since D. I. Mendeléeff first fitted the elements into a table according to their mass and noted repetition of chemical properties at certain regular intervals, there have been missing spaces where elements not yet discovered were expected to fit. The brilliant research of H. G. J. Moseley on the x-ray emission lines of the elements and his concept of atomic number called attention to these blank spaces even more strikingly.

By the third decade of the present century only seven of the blank spaces between hydrogen and uranium remained unfilled. In the following twenty years three more were filled, leaving only the elements with atomic numbers 43, 61, 85 and 87 to be discovered.

During all of this time there was no indication of a reason why uranium (atomic number 92) should be the heaviest element capable of existence. Yet no heavier element was found, although uranium had been known for some 150 years.

It was recognized by workers in radioactivity that all elements above bismuth were unstable toward radioactive disintegration, and that their existence in nature was due only to the fact that uranium and thorium possessed isotopes which were stable enough to keep in existence a small amount of most of the other elements from bismuth to uranium. After the discovery that elements could be transmuted to other elements by bombardment with nuclear particles, many of these workers, no doubt, reasoned that it might be possible to produce artificially elements heavier than uranium.

The first recorded attempts to produce the transuranium elements were those of E. Fermi in 1934. Although the original purpose was not attained, his work started many other investigators on the problem and finally led to the discovery of nuclear fission by O. Hahn and H. Strassmann. Thus the early search for the transuranium elements may be considered responsible for the discovery of nuclear fission and the numerous consequences of that discovery.

Many scientists continued in the search for elements above uranium. Reasoning by the rules of the periodic table, as it was then shown, chemists believed that element 93 should be very similar to rhenium. They therefore attempted to isolate

element 93 by the methods which would isolate rhenium. All these attempts failed. Finally, in 1940, E. M. McMillan and P. H. Abelson did succeed in producing submicroscopic quantities of element 93 by the bombardment of uranium with neutrons. The new element was detected and followed through chemical processes by virtue of its radioactivity. It was found that element 93 was not at all similar to rhenium, its expected homologue, but was instead very similar to uranium.

In selecting a name for element 93, its discoverers observed that when uranium was discovered some 150 years previously it had been named after the outermost planet then known, Uranus. In the meantime two more planets had been found beyond Uranus, the first of which was Neptune; so they decided to name the element neptunium. The isotope Np^{239} which McMillan and Abelson produced is so short lived that it is not possible to produce amounts which can be seen even under the most powerful microscopes. Another isotope, Np^{237}, was subsequently produced. This does have a very long life, making it possible to isolate visible and weighable amounts of neptunium.

Element 94, the second of the transuranium elements, was also second in order of discovery. This element, which was named plutonium after Pluto, the second and last known planet beyond Uranus, was first prepared and recognized, late in 1940, by G. T. Seaborg, McMillan, A. C. Wahl and J. W. Kennedy. They bombarded uranium with deuterons and observed that a short-lived neptunium activity was produced which was different from the Np^{239} obtained when neutrons are used as bombarding particles. Upon decay of this neptunium, another type of radioactivity began to appear. Chemical studies proved that this new activity resided in an element different from all the 93 previously known elements. This was correctly interpreted to mean that it was due to element 94, the isotope Pu^{238}. Another isotope is the famous Pu^{239} which is of great importance because it can be made in large quantities and because it, like U^{235}, undergoes fission with slow neutrons. It was used in some of the atomic weapons and will some day be the basis for an atomic energy industry.

Even the very earliest studies of the chemistry of plutonium revealed that it, like neptunium, bears a much greater similarity to uranium than to osmium which might have been expected to be its homologue. The importance of plutonium in atomic energy has caused a very intensive chemical research program to be carried out, so intensive, in fact, that in the few years since its discovery its chemical properties have become as well or better understood than those of most of the other elements in the periodic system. These studies and those on the chemical properties of neptunium led to the view that the accepted version of the periodic system should be changed in the region of high atomic numbers so that the elements starting with thorium form a series similar to the rare-earths. This places actinium in a position similar to lanthanum, and since the rare-earths have been called the "lanthanide series," the new series is often called the "actinide series."

The next transuranium element to be found, that with atomic number 96, was detected in 1944, actually a short time before element 95, the last transuranium element to be discovered. Element 96 was produced by bombarding plutonium, itself an artificially produced element, with helium ions. The discoverers, Seaborg, R. A. James and A. Ghiorso, who decided to name this element after Marie and Pierre Curie, selected the name curium and the symbol Cm. Naming the element after a person was decided upon because of the similarity of the position of curium in the actinide series to the position of gadolinium in the lanthanide series. Gadolinium was named in honor of the Finnish chemist, Johannes Gadolin.

(*Continued on Page 102*)

PERIODIC TABLE SHOWING HEAVY ELEMENTS AS MEMBERS OF AN ACTINIDE SERIES

1 H 1.008																1 H 1.008	2 He 4.003
3 Li 6.940	4 Be 9.02											5 B 10.82	6 C 12.010	7 N 14.008	8 O 16.000	9 F 19.00	10 Ne 20.183
11 Na 22.997	12 Mg 24.32	13 Al 26.97										13 Al 26.97	14 Si 28.06	15 P 30.98	16 S 32.06	17 Cl 35.457	18 A 39.944
19 K 39.096	20 Ca 40.08	21 Sc 45.10	22 Ti 47.90	23 V 50.95	24 Cr 52.01	25 Mn 54.93	26 Fe 55.85	27 Co 58.94	28 Ni 58.69	29 Cu 63.57	30 Zn 65.38	31 Ga 69.72	32 Ge 72.60	33 As 74.91	34 Se 78.96	35 Br 79.916	36 Kr 83.7
37 Rb 85.48	38 Sr 87.63	39 Y 88.92	40 Zr 91.22	41 Cb 92.91	42 Mo 95.95	43 Tc	44 Ru 101.7	45 Rh 102.91	46 Pd 106.7	47 Ag 107.880	48 Cd 112.41	49 In 114.76	50 Sn 118.70	51 Sb 121.76	52 Te 127.61	53 I 126.92	54 Xe 131.3
55 Cs 132.91	56 Ba 137.36	57 La 138.92	58-71 SEE Le SERIES	72 Hf 178.6	73 Ta 180.88	74 W 183.92	75 Re 186.31	76 Os 190.2	77 Ir 193.1	78 Pt 195.23	79 Au 197.2	80 Hg 200.61	81 Tl 204.39	82 Pb 207.21	83 Bi 209.00	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	SEE Ac SERIES														

LANTHANIDE SERIES	57 La 138.92	58 Ce 140.13	59 Pr 140.92	60 Nd 144.27	61 Pm	62 Sm 150.43	63 Eu 152.0	64 Gd 156.9	65 Tb 159.2	66 Dy 162.46	67 Ho 163.5	68 Er 167.2	69 Tm 1694	70 Yb 173.04	71 Lu 174.99
ACTINIDE SERIES	89 Ac	90 Th 232.12	91 Pa 231	92 U 238.07	93 Np 237	94 Pu	95 Am	96 Cm							

Isotopes in Freshman Chemistry

• **By Mel Gorman, Ph.D.** *(Stanford University)*
DEPARTMENT OF CHEMISTRY, UNIVERSITY OF SAN FRANCISCO, SAN FRANCISCO, CALIFORNIA

In the freshman course when, where, how, and to what extent should isotopes be studied? Have teachers and textbook authors given this question adequate thought? This study offers a negative answer.

An examination of twelve of the most used college textbooks reveals information that prompts Dr. Gorman to suggest certain remedial procedures.

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For about twenty-five years the subject of isotopes has been presented to freshman chemistry students as an appropriate topic under the general heading of the atomic nature of matter. The existence of isotopes was established from experiments on the properties of the radioactive elements and their disintegration products. At first little more than mere mention of isotopism among the heavy elements could be made in freshman textbooks. After each experimental or theoretical impetus which spurred expansion of our knowledge of isotopes, there followed in due time an increased treatment of this subject in the new editions of college textbooks.

The discovery of fission and the development of the uranium chain-reacting pile constitute the most recent milestones in the progress of our knowledge and application of isotopes. Explanation of the manufacture and use of the atomic bomb in terms of the isotopes involved, and the use of radioisotopes produced by the atomic pile have emphasized the importance of the topic. This has been reflected in elementary chemistry texts, where more space than ever before has been allotted to isotopes in the new editions.

This paper reports the results of a study of the treatment of isotopes in 12 widely used freshman chemistry books, most of which have been revised within the last few years. We wanted to learn the various methods which the different authors use to introduce the subject, to find out to what extent and in what manner the applications and related topics are discussed, and, if possible, to suggest means of improving the presentation.

Development of the Topic

A rather uniform manner of introducing isotopes was found in most texts. It consists in presenting the experiments of positive ray tubes or mass spectrographs, or both, in relation to the existence of fractional atomic weights. Some authors begin by giving examples of elements with chemically-determined atomic weights which are far removed from integer values, like chlorine; then describing the analysis of such an element with the mass spectrograph; and, finally, explaining how the atoms of different weight contribute to the average chemically-determined atomic weight. Other writers begin by describing how the mass spectrograph reveals that an element can have atoms of different weights, and then show that such observations are concordant with the fractional atomic weights determined chemically. During these explanations a definition of isotopes is given explicitly, or else implied from the context.

Two texts introduce the concept of isotopes deductively from the standpoint of atomic structure. The student is reminded that since practically all the weight of an atom is in the nucleus, and the protons and neutrons therein each have an atomic weight which is very close to one, it would be expected that all atomic weights should have close to whole number values. That certain elements have atomic weights considerably removed from integers is then explained by means of mass spectrographic analysis.

Two authors develop the subject from the discoveries relating to the atomic weights of various radioactive decay products, such as ionium and thorium, followed by an explanation of the mass spectrograph and its results. This constitutes almost a historical approach to the discovery of isotopes.

Where Introduced

With regard to the portion of the books where isotopes are treated first, we found that 11 had this subject in the first half, and of these 5 accomplished the introduction within the first fifth of the text. Another point looked for in the survey was the place where isotopes were first introduced relative to where the subject of atomic structure is given. In 3 texts isotopes precede atomic structure, in 6, isotopes accompany atomic structure, and in 4, isotopes appear at a place after, and considerably removed from, the study of atomic structure.

Separation and Applications of Isotopes

The separation of isotopes is treated in a variety of ways. In contrast with the introductory presentation of isotopes, there is no uniformity in the description of the means of separating isotopes. Some authors place separation at the end of their discussions about the existence or structure of isotopes, and others place it much later on in the course in connection with various applications. The space allotted to separation varies from a few lines to a couple of pages. Separation as a topic is frequently explained by using hydrogen or uranium as an example.

With regard to application, every text describes the use of tracer isotopes. Most books use radioisotopes as

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Changes in Starch Grains

• **By J. C. Ireland, Ph.D.** *(University of Chicago)*
PROFESSOR OF AGRONOMY, OKLAHOMA A. & M. COLLEGE, STILLWATER, OKLAHOMA

When oat, corn, or wheat seeds are exposed briefly to electronic energy of certain radio frequencies there is an apparent stimulation of growth. Is it due to changes in the starch and protein granules at the time of exposure?

Ordinary microscopic examination shows no variation in cell structure.

The electron microscope tells a different story.

When oat, corn, and wheat seeds are exposed to electronic energy of certain radio frequencies, there is an apparent stimulation of growth. This is shown by the speed of seedling growth and by the yield. The purpose of this project has been to find out whether there are changes taking place within the starch and protein granules of the seeds, at the time of exposure. Examination with the higher powers of the "light microscope" did not show any variations in the cell structures or in the starch grains. The electron microscope, with a magnification of about 4000 diameters, did show some interesting differences.

One of the difficult problems of studying starch grains with the electron microscope is to obtain very small particles uniformly distributed over a screen. The finely ground seeds were suspended in distilled water and forced through a homogenizer. An inexpensive laboratory type was used. The small circular screen used for mounting specimens in the evacuated tube of the electron microscope, was covered with a thin film of formvar. A drop of the starch suspension was dried upon this film and examined by means of a light microscope. This method enables the worker to determine whether the film is too thick, or whether the particles are uniformly distributed. The rays of the electron tube will not penetrate a thick film. Ethyl acetate may be used to dissolve some of the film and remove excess starch from the screen. The embedded grains will dry quickly, and the screen may be mounted inside the observation chamber.

A number of screens may be prepared and held upon an ordinary glass microscope slide by means of scotch tape until they are ready to use. Numbers placed upon the outside of the tape with India ink will prevent confusion. With a magnification of a little less than 5000 diameters, it is possible to scan several squares of the screen with the electron beam, to find out differences or irregularities in the mount. When a representative particle has been selected, the focus is sharpened, and the field is ready to photograph.

For the smaller electron microscopes, 2″x2″ glass plates are used for the pictures, preferably with a slow orthochromatic emulsion. Very sensitive panchromatic films are not satisfactory for recording electron beams, and the glass plate is necessary to prevent warping of the emulsion by the heat. The larger electron microscopes use a 2″x10″ glass plate which may record five successive exposures.

In Plate I, five exposures each of oats, corn and wheat are shown. The bottom three are from untreated seeds, indicating a wide difference in size and surface. Observe

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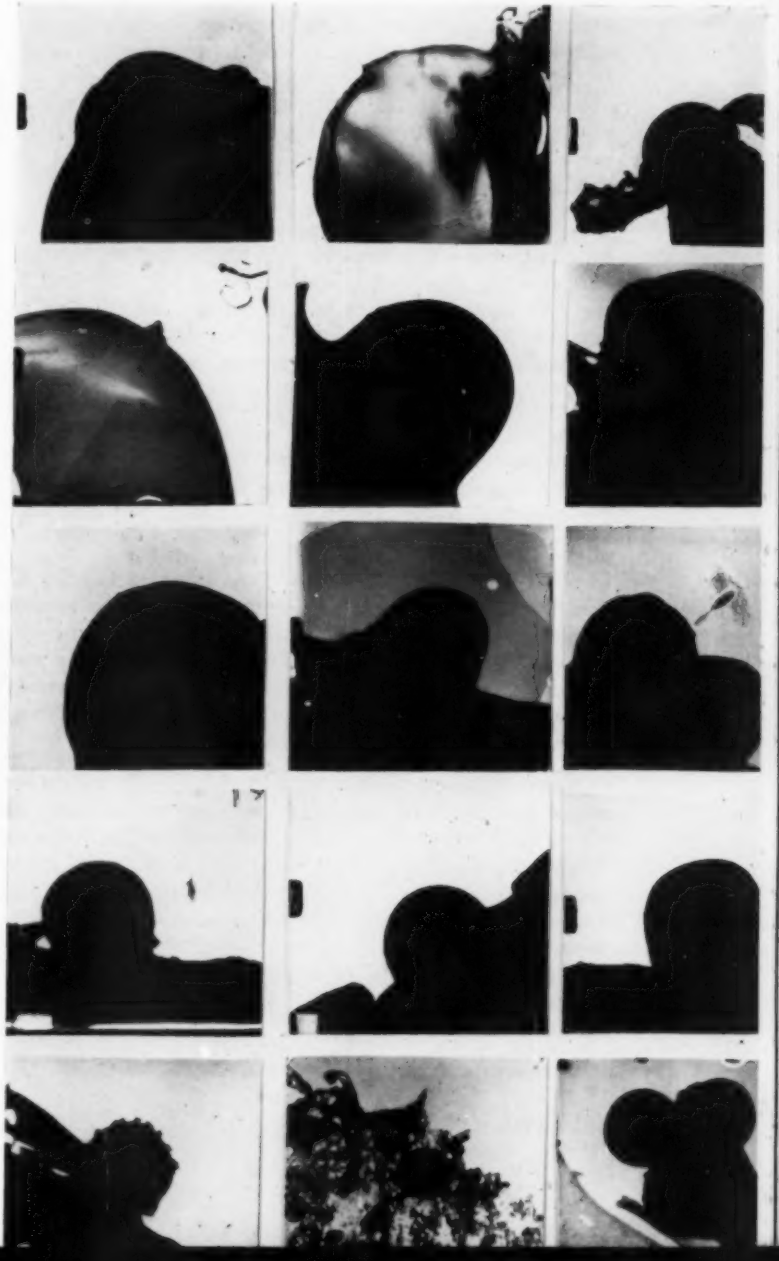
STARCH GRAINS UNDER THE ELECTRON MICROSCOPE
Left, OATS Center, CORN Right, WHEAT
Lower photographs show untreated starches. Those immediately above show the results of a 15-second exposure. The others in sequence show the effect of 30-, 60-, and 120-second exposures.



The Evolution of Physical Experiments

• **By Brother D. John, F.S.C., Ph.D.** *(Catholic University)*
LA SALLE COLLEGE, PHILADELPHIA, PENNSYLVANIA

Modern researchers have it easy!

Even Paul Heyl would admit that using modern methods and devices and with the Bureau of Standards to assist him, in 1930 he had no difficulties comparable to those surmounted by Bouguer in Peru in 1740.

This is an interesting bit of history in which are contrasted the research techniques of the 18th and 20th centuries in determining the gravitational constant in the fundamental law discovered by Newton.

●

It is indeed a rarity in the history of physics that an experiment performed in one century to determine a constant of nature will be repeated two centuries later, to determine the same constant. Physical theories are often so fundamentally altered in the space of a few years that experiments of bygone centuries have little more than historical interest for the experimental investigator.

It is therefore doubly interesting that the gravitational constant in the fundamental law discovered by Newton has been the object of research both in the 18th and in the 20th centuries. These two investigations allow us to compare the techniques employed at the dawn of the scientific era with those used in our own day.

Newton had formulated his law, that the force of attraction between two masses was directly proportional to the product of the masses, and inversely proportional to the square of the distance between them. Thus,

$$F = \frac{K\, m_1\, m_2}{d^2}.$$

In order to find the value of the proportionality factor K, the value of the two masses would have to be known whose force of attraction and whose distance apart could be measured. The attraction of the earth for a body was unsuitable, for the mass of the earth was unknown at that time. The attraction of two reasonably sized spheres would be much too small to be measured.

Newton had suggested that the mass of a mountain might be calculated from its dimensions and a study of its mineral composition, and that possibly the force of attraction of its mass for another mass might be large enough to measure. If this could be accomplished, the value of K in the gravitational formula could be calculated; with this value, determining the mass of the earth would be a simple matter. With a knowledge of the earth's mass, the mass of the moon could be found, as well as that of the sun and the planets.

Bouguer and de la Condamine, members of the French Academy, set out in 1740 for Peru, where along with other scientific investigations they were to attempt to perform the experiment suggested by Newton. The mountain Chimborazo is located in this country. Its size and symmetry make it admirably suited for the experiment in question.

The difficulties of the undertaking have been related by Bouguer in his report to the Academy:

> "If we had to overcome many difficulties it is certain that many of them are inseparable from such undertakings; when it is necessary to cross the ocean to a country so distant as to render all communication with Europe extremely difficult, and when the success of the mission depends on such a number of circumstances, and the concurring of so many persons, the moral difficulties are then multiplied and unite themselves with local and physical ones. The first have been greater than can be described, and the extent of the latter may be conceived when you are informed, that the vast height of the mountains which in Europe have commonly contributed to accelerate these operations were to us the greatest hindrance, either from the circumstance of being stationed so high as to be enveloped in clouds, or having our signals carried away by the tempests, and being frequently reduced to having regard to nothing but our safety. We have sometimes been obliged to purchase, for a month and a half's patience, a single quarter of an hour of fine weather; and in one of these stations have been longer detained than we should have been toiling through a whole meridian in Europe. We are working too, in a country to which even its inhabitants themselves are strangers; and obliged continually to penetrate into deserts, where no paths but those made by wild beasts were to be discovered."

To the strangeness of the country Bouguer adds the ferocious attacks of clouds of tropical insects and of poisonous vipers. He speaks of the mosquitoes as "a species of flies scarcely perceptible, and affect you like red-hot iron." The heat of the tropics presents its own woes. "To the degree the faculties of the soul find themselves incumbered, the lassitude of the body communicates itself to the mind; and we then find ourselves in a state of indolence, which not only prevents us from acting, but unfits us for anything that requires application and attention."

The extreme difficulty of the ascent of the mountain chain to the base of Chimborazo presented a contrast from tropical heat to a region where "to the greatest distance around me I found nothing but snow and hoar frost." Once all these many obstacles had been overcome, the scientific experiment could be performed.

The technique was to suspend a weight by a long thread; the mass of the earth would attract it downward, while the mass of the mountain would pull it side-

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A Multi-purpose Conductivity Demonstration

• **By Frederic B. Dutton, Ph.D.** *(Western Reserve University)*
DEPARTMENT OF CHEMISTRY, MICHIGAN STATE COLLEGE, EAST LANSING, MICHIGAN

Having seen Dr. Dutton use it, we know how effectively he employs this simple apparatus.

The skill of the demonstrator is perhaps more important than this apparatus set-up, which can be used for several purposes. But any instructor can teach more effectively with good tools.

Here are hints for teachers and demonstrators that are worthy of consideration.

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Perhaps no piece of demonstration apparatus has been described so frequently as that used to demonstrate the conductivity of solutions. The one in use at Michigan State College is a combination of several suggested by various authors.

A stand supports two light sockets, a pair of heavy copper wire electrodes, and a tubular separatory funnel. It is high enough so that a liter beaker may be easily slid into place beneath the funnel. This arrangement is indicated in Fig. 1.

The socket on the right is wired in series with the electrodes and the 110 volt A. C. line. The socket on the left is independent of the other and is wired in series with a rheostat and the 110 volt A. C. line. The latter is used as a reference when comparisons are to be made between the conductivities of various solutions.

If glass blowing facilities are available, the separatory funnel is best made from a large (50 mm.) test tube and a large bore (3-4 mm.) stopcock to make possible rapid removal of solutions.

In use, the apparatus is connected to the 110 volt line and with the funnel in place a series of acids, bases, salts, and non-electrolytes in solution are tested for conductivity using 30 watt light bulbs in the sockets.

An interesting problem is put to students when the conductivity of dilute ammonium hydroxide, and dilute acetic acid are measured separately, and then after mixing, the brilliance of the light bulb on the left being adjusted to match that measuring the conductivity of the previous solution for purposes of comparison. This provides a good opportunity for the discussion of weak acids and bases.

The conductivity of distilled water may be demonstrated by replacing the 30 watt bulb with a 1, 2 or 3 watt neon or argon lamp.

The variation of the degree of ionization with dilution is readily demonstrated with acetic acid. The funnel must be dry and when filled with glacial acetic acid will show no apparent conductivity when measured with the 30 watt bulb. Addition of a small amount of water increases the conductivity sufficiently so that the bulb will glow dimly. Increasing replacement of a portion of the acid with water is accompanied by increasing conductivity until the dilution factor reaches a point where the ion concentration begins to diminish and this is indicated by reduced brilliance of the lamp.

Removing the funnel and replacing it with a beaker supported on the small platform that is swung into place, makes possible the use of this apparatus for a conductometric titration. A buret is mounted over the beaker as shown in Fig. 2.

Ten ml. of 0.1 N barium hydroxide is added to about 100 ml. of water in the 250 ml. beaker along with a few drops of phenolphthalein indicator. Upon careful addi-

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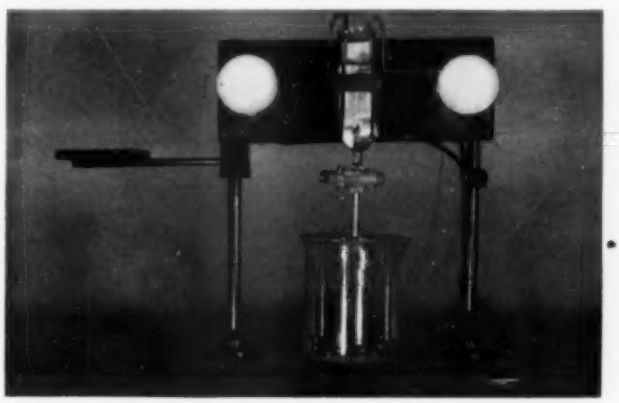

Figure 1—CONDUCTIVITY APPARATUS

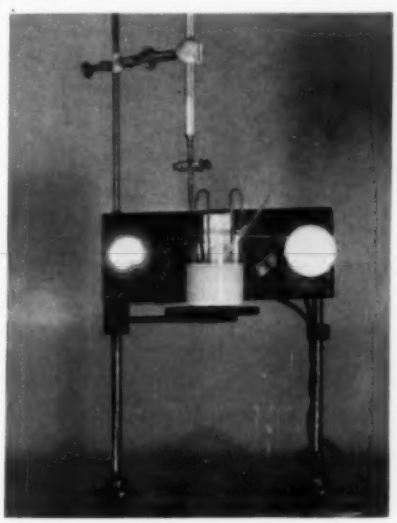

Figure 2—APPARATUS arranged for a conductometric titration

The Mechanical Properties of Human Bones

• A Technical Report

FROM THE NATIONAL BUREAU OF STANDARDS, U. S. DEPARTMENT OF COMMERCE, WASHINGTON, D. C.

How much physical shock will the body stand? How much compression can human bones undergo before shattering? Are our bones as strong as steel? As hickory wood?

The development of high speed aircraft has created new problems concerning safety devices that will require much research for their satisfactory solution.

Here is an account of work already accomplished.

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Recent developments in high-speed aircraft have caused flight personnel to be subjected to numerous shocks and impacts in ordinary flights as well as those encountered in accidents. This has made it increasingly important that safety devices be developed for the protection of the human body. It was apparent that in order to establish logical criteria for the design of these devices, a systematic and thorough study of the effects of impacts on the human body was needed. In conjunction with such a study being conducted by the Naval Medical Research Institute, the assistance of the National Bureau of Standards was requested when it was realized that progress in the investigations depended on close cooperation between the engineering and medical professions in order to cope with the mechanical as well as the pathological problems involved.

Research with human bones by Frank C. Smith of the National Bureau of Standards has indicated that ordinary laboratory techniques and instruments may be applied to obtain the much needed data on the mechanical properties of bone—knowledge necessary in predicting body behavior under impact loads as encountered in aircraft crashes, seat-ejection from aircraft, parachute opening, and exposure to blast. Dr. Paul Calabrisi of the George Washington Medical School and the Naval Medical Research Institute is collaborating in the study particularly in connection with the anatomical problems encountered. Preliminary but significant results have been obtained in these investigations.

Many instances are known of aircraft and other vehicles crashing to complete destruction where occupants emerge from the wreckage miraculously unhurt. Conversely, a relatively slight blow to certain sensitive portions of the body may have serious and even fatal consequences. It has also been found that naval personnel have been seriously injured from exposure to blast or sudden displacements of ship's structure following the explosion of torpedoes or mines, or the firing of guns.

Since the human skeleton provides support for the body and protection for vital organs, it was decided to begin the study with an investigation of the mechanical properties of human bones and joints. Results are to be used in the design of simplified mechanical models of the human frame which will make possible an estimate of the forces set up in the body during impacts of various types.

There is nothing new in regarding the human body as a mechanical structure. The earliest study of the mechanical properties of bone is believed to have been made by Galileo about 1638, in connection with his classical work on beam mechanics. European investigators began to regard the body frame from a structural viewpoint about 1832, and much work was done during the succeeding century in an attempt to apply theoretical mechanics to the human frame and its components. Another attack on the problem is justified at this time by the spectacular advances, made in recent years, in the technique of measuring strain and other mechanical quantities which have come about largely through research on the behavior of aircraft, both in flight and in the laboratory.

The study was initiated with measurements of the mechanical properties of the structural members of the skeleton, beginning with long bones, and was designed to establish average values on a statistical basis. The initial work involved seventeen tests on specimens made from bone of the compact type removed from near the middle of the bones of the extremities of humans and monkeys. Fourteen of these tests were made in compression with the direction of the load parallel to the fibers of the bone. One was made in compression with the direction of the load perpendicular to the bone fibers, one in bending, and another under torsion load. Test specimens consisted of sections removed from the bones, and of portions machined into plates and hollow cylinders.

To obtain the mechanical properties of a substance it is necessary to know the compression or extension (strain) of the material for a given load (stress). Given the specimen's average cross-section and the load, applied and measured in these investigations with a standard hydraulic-type testing machine, the stress on the specimen may be computed from elementary formulas of strength of materials. The strain in the bone specimens was measured with wire-resistance and Tuckerman optical strain gages to an estimated accuracy of ±0.000002 in/in. During the investigation simultaneous strain measurements using both types of gages showed that the electrical strain gage could be used successfully on dry bones but would not function properly on fresh bone because of the inadequate bond between the gage and the oily surface. Earlier data obtained with this

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Conservation Education for Teachers

• **By George J. Free**

SCHOOL OF EDUCATION, PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PENNSYLVANIA
IN CHARGE, PENNSYLVANIA CONSERVATION EDUCATION LABORATORY FOR TEACHERS

America's natural resources are not inexhaustible. We must conserve. A wasteful nation must be shown the necessity for conserving. Teachers can help.

In some states the teaching of conservation in the schools is mandatory; in others it is encouraged. But many classroom teachers are not at home in this newly recognized field. They would profit from participation in a summer workshop.

This article tells how a workshop is conducted and what it can accomplish.

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The gargantuan demands of war on the nation's natural resources have jolted a few thinking citizens to an awareness of our rapidly diminishing natural resources. Primed by these few citizens, an increasing tide of realization of the need to conserve natural resources is slowly but surely seeping into our national consciousness.

How may we have a citizenry capable of understanding resource problems, with the ability to pass judgment on their proper solution? The answer is education; education of adults but, more important, education of children now in school who will soon shoulder the responsibility of trusteeship of the nation's resources.

The responsibility of instructing pupils in conserving natural resources lies with the classroom teacher, the backbone of our educational system. Since few teachers admit competency in this newly recognized field it seems that the most expeditious procedure is to educate teachers in the basic philosophies and practices underlying the conservation of natural resources.

Teaching conservation doesn't mean that the teacher must prepare himself by taking additional courses in chemistry, physics, geography, social studies, mathematics and other subjects, but rather that he reshuffle his knowledge and view his world from a different angle—an angle that is likely to cut across subject-matter boundaries and bring him closer to the realities of living in a free country that he must help keep free.

Our country's achievements in material progress, prosperity and high standards of living have been possible because of an abundant supply of natural re-

FROM A MOUNTAIN VANTAGE POINT, teachers examine land-use problems. (Photograph by D. L. Batcheler, Pennsylvania Game Commission.)

sources. In securing these achievements we have been a very wasteful people. Much of our rich heritage has been exploited, wasted, squandered and devastated.

Soils on the southeastern seaboard became depleted by continuous cropping of cotton, sending the planters westward to the Mississippi and later to Texas and Oklahoma for new, rich soil. Forests in the East were devastated by ruthless cutting and fire, so lumbermen pushed the search for good timber ever westward. Rivers and lakes teemed with fish; forests with game. Much of this wildlife has been destroyed. Streams that ran clear are now muddy with topsoil, and many are polluted with man-made wastes. The waste of our mineral resources has been enormous. Already the most easily extracted ores are gone. We have long trusted to new discoveries to take the place of those lost through carelessness, but new discoveries have just about reached the vanishing point.

This is a black picture to contemplate—a picture of waste, extravagance, greed, selfishness, ignorance and carelessness. Theodore Roosevelt once said that a nation may solve its social and economic problems but if it does not solve the most fundamental of all problems, the conservation of natural resources, it will have worked in vain.

No longer can we sidestep our economic problems and avoid depressions by exploiting new resources. The country now is settled and we must use wisely the resources that are remaining.

A few states have made mandatory the teaching of conservation of natural resources; a few have encouraged their teachers by publishing and distributing pamphlets and other teaching aids; a few more, like Pennsylvania, have set up summer workshops providing conservation experiences for teachers.

Let's examine the Pennsylvania Laboratory, as an example, and see what it offers to interested teachers. The Pennsylvania Conservation Education Laboratory for Teachers was established in 1946 and sponsored by various departments of the state government and by some sixty interested civic organizations. The Pennsylvania State College was designated to operate the Laboratory. Civic organizations contributed $50.00 scholarships for all teachers attending, so that the cost to each teacher was only $13.75. Enrollment was necessarily limited to thirty-five teachers in each of two three-week sessions each summer. Teachers with three years' teaching experience in Pennsylvania were drawn from primary grades on through high school; from urban and rural areas with varying degrees of preparation ranging from minimum essentials to those of Doctor's ratings.

The Laboratory is housed as a unit complete within itself in an especially suitable fraternity house in State College. Here with almost ideal living conditions, including dormitories, excellent meals, a well stocked library, and a clubroom converted into a classroom, the teachers worked and lived together in a spirit of cooperation, keen interest and a oneness of purpose. From this headquarters, field trips were conducted daily in chartered busses to study in detail examples of Pennsylvania's wealth of natural resources.

The Conservation Laboratory was especially fortunate in being able to enlist the services of excellent personnel from the faculty of the College. These outstanding men drew from their wide experience of scientific knowledge to give accurate, unbiased information on such resources as minerals, waters, forests, soils and wildlife. This factual material coupled with the experience of well planned, well conducted excursions, awakened teachers not only to the wealth Pennsylvania possesses but also to the problems involved in utilizing its wealth wisely.

Pennsylvania's mineral resources were explored by examining out-cropping of rock layers on mountain sides, quarrying operations were observed, and the process of brick manufacture was traced from the ganister at the mountaintop until it evolved into finished firebrick at the foot of the mountain. Strip coal mining was viewed and its problems of the utilization of the mauled earth, reforestation, and possible water pollution became a reality. A trip into the depths of an active coal mine revealed not only the veins of various grades of coal but the multitudinous problems of maximum recovery, minimum waste, safety, and other major problems of operation. Teachers learned the relationship of Pennsylvania's economic stability and the wise conservation measures necessary to prolong the supply of these vital, non-renewable resources.

A forest became more than a mere stand of trees after trips to College plantations, woodlots, and experimental and virgin forest areas with the details of proper management illustrated. Problems of control for present as well as future use were disclosed by treks through these areas. Teachers became aware of the vastness of the relationships of growing trees to land utilization, soil control, water conservation, and wildlife protection. A visit to the Greenwood state forest nursery under the guidance of the district state forester gave evidence of the measures the State is taking, and the problems involved in perpetuating another of Pennsylvania's priceless resources—forests.

Soil samples were examined, profiles investigated, and the relationships of good plant growth to soil fertility were scrutinized in the field. By visits to productive farmlands where conservation practices were employed, teachers visualized the value of contour plowing, crop rotation, diversion ditches, and proper application of fertilizers as a means of producing greater crop yields and the maintenance of higher stock population. In contrast, the disastrous results of uncontrolled erosion were evident where conservation practices were ignored. Thus the need for efficient manipulation of soil became paramount in its relation to the food production of the state and the nation.

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for SEPTEMBER, 1948

NEW BOOKS

Understanding Science

• *By* WILLIAM H. CROUSE. New York: McGraw Hill Book Co. 1948. Pp. VIII + 190. $2.20.

Even pupils who think they dislike science will find this book easy to take. They will approve its plain clear language, its disarming approach, its striking analogies, its gay, well-captioned illustrations. Every page shows that the writer knows students as well as science. He discusses briefly and simply such basic scientific phenomena as heat, electricity, light, and atomic structure. Then he considers the modern inventions that are related to or based on them—complex ones such as the atomic bomb, radar and television, as well as the telephone, phonograph, photography, the internal combustion engine, and others encountered every day and about which most people know so little.

High school pupils should not plan to use this book for home study. Their parents will not want to give it up!

H.C.M.

The Machinery of the Body

• *By* ANTON J. CARLSON and VICTOR JOHNSON, Chicago: The University of Chicago Press. 1948. Pp. 639. $4.50.

This third edition of a well-known text in physiology, intended for students with little or no experience in science, has many desirable features not found in other works to be used in the elementary course. When the first edition of this book appeared in 1937, sound films had just begun to take the integral part they now have assumed in the science teaching program. This text uses for illustrations scenes taken from films in the Chicago biology series. Thus the student has the opportunity to correlate with reference reading what he has seen in the film. In the present edition, the use of these pictures has been greatly enlarged.

The book is written in an easy to read style reminiscent of a personal chat. The more elementary material is presented under sections not starred and is complete within itself, while starred headings delve more deeply into the subject to provide further facts for the interested student. The 1948 revision includes the advances made by science in recent times such as radioactive tracers, cancer, blood banks and the new drugs (penicillin and the sulfas).

The authors deal with a complete range of physiological behavior and approach their material from the evolutionary point of view. *Alfred Halpern*

Chemical Russian, Self-Taught

• *By* JAMES W. PERRY. *Contributions to Chemical Education. No. 4.* Easton, Pa.: Journal of Chemical Education. 1948. Pp. VII + 221. $3.00.

To the person brought up exclusively on the English language the learning of the Russian language becomes a very difficult task. After he has mastered the strange alphabet, the obstacle of the Russian declensions, conjugations, and the subtle use of prefixes and suffixes, usually is overwhelming, unless conquered by extensive study.

The series of articles published by the author in the *Journal of Chemical Education* over a three year period (1944-1947) is now presented in book form. Roughly one-fourth of the text, excluding the glossary of over 1,500 Russian technical terms, is devoted to the Russian grammar. A systematic discussion of the Russian nomenclature of inorganic and organic chemistry occupies approximately one-half the text. The student of chemical Russian is advised by the author to do supplementary reading of Russian chemical literature of known subject matter, such as a simple textbook, in conjunction with the study of this book.

Whether the plan presented by the author can succeed in teaching the average chemist to read and understand the Russian chemical literature, must be proven in time by those who actually undertake this task. The author, however, is convinced that one year of study (one hour per day) prepares the student sufficiently to tackle current Russian journals "with gratifying results." *Harry H. Szmant*

Student's Handbook of Science

• *By* BERNARD UDANE and HERMAN W. GILLARY. New York: Frederick Ungar Publishing Co. 1948. Pp. 208. $0.75.

Something new for the high school student of science. Someone was bound to get the idea eventually. Messrs. Udane and Gillary of the Forest Hills High School, New York, have beaten the field with a little volume that should be put in every student's hands when he begins the study of science so that he may have the advantage of using it throughout his high school career. In this Handbook he will find answered many of the questions that will come to mind as his science interests develop. Here he is given specific help in learning how to study and how to draw, how to keep a good notebook, how to use a library, and how to develop extracurricular science interests. Used in connection with a textbook in any science it will stimulate the student's interest, ease his labor, and increase his success.

The publishers were wise to prepare this excellent teaching aid in an inexpensive but fairly durable form so that it can be sold for 60 cents in lots of 10 or more. Teachers may purchase an introductory copy for the same price. They cannot afford not to risk that much for the good of their students. *H.C.M.*

Wild Folk at the Pond

• *By* CARROLL LANE FENTON. New York: The John Day Co., 1948. Pp. 127. $2.00.

Not much good science literature for the very young is to be found on the bookshelf when teachers seek material for use in their classes.

Here is a delightful new book, the second of a series, for boys and girls 5 to 10 years old. Children who are able to read will want to read it themselves. Younger children will enjoy listening to its pleasant tales. The 14 stories deal with animals that live in or near ponds, not only turtles and frogs and clams and crayfish and bullheads but also raccoons and kingfishers and herons and red-winged blackbirds and a number of other members of a pond community.

Sentence structure, vocabulary and incidents have been carefully adjusted to the age group. The thirty illustrations, many of them full page, were drawn by the author who is a clever artist as well as a skilled writer of juvenile science. *R.M.F.*

The Earth and Its Resources

• *By* VERNOR C. FINCH, GLENN T. TREWARTHA, and M. H. SHEARER. New York: McGraw-Hill Book Company, Inc. 1948. Pp. viii + 584. $3.20.

The second edition of this textbook for high school courses in physical geography and earth science impresses first by its fine appearance—its format, type selection, illustrations, and binding—and then by its broad coverage, its teachability and its up-to-dateness. It is written in a way to challenge the interest of both pupil and teacher.

Conservation is much in the public mind at the present time, and the authors have done well to include a complete section on the natural resources of the United States, their occurrence, location, and distribution. A helpful list of visual aids is supplied for use in connection with each chapter. The appendices include a brief discussion of rocks and minerals, meteorological instruments, the weather map and much other useful information and data. A laboratory manual to accompany the textbook is available. *H.C.M.*

The Chemical Formulary

• *By* H. BENNETT, Editor-in-Chief. Brooklyn: Chemical Publishing Co., Inc. 1948. XXVI + 448. $7.00.

The latest volume of this useful Formulary follows the plan set by earlier volumes and will receive a cordial reception. The fact that some 65 scientists—most of them active researchers or industrial scientific workers—helped plan Volume VIII, guarantees that the formulas offered are workable, and used in current practice.

The formulas are new, not reprints from earlier volumes. Some of them are of German origin and have just been released for American use. Adhesives, cosmetics, farm and garden preparations, insecticides, food and drug products, plastics, and a score of other fields, receive attention. The Formulary is a storehouse of information and data and ideas as well as formulas. Manufacturers as well as small scale workers will find it of value. *H.C.M.*

★ ★ ★ ★ ★

"Consider, for example, the typical high school textbook in science. There may be short descriptions of the men who made scientific contributions and there may be names and dates; but there it little which helps the student to develop an appreciation of what it means to control the significant variables, the price that must be paid to apply this method, the difference between a good experiment and a poor one, or some of the difficulty man has experienced when he has tried to interpret and use the findings from studies in which the significant variables were not controlled."

RALPH H. OJEMANN
University of Iowa
Science

Transuranium Elements

(Continued from Page 93)

Microscopic quantities of curium have been isolated in spite of the relatively short life of all known isotopes. A quantity of the material which is large enough to be visible is so intensely radioactive that it glows visibly in a darkened room. The picture shown here was taken without any light except the glow of the curium.

The last transuranium element to be discovered is the one with atomic number 95. This element was produced and shown by chemical means to be different from all other known elements by Seaborg, and James and L. O. Morgan, in 1944 and 1945. In naming it the pattern set in the case of curium was followed. The element similar to element 95 on this basis was europium; so element 95 was named americium after two American continents.

Visible and weighable amounts of americium have also been prepared, thus completing the isolation of all four transuranium elements in the form of relatively pure compounds.

Whether or not elements with atomic number higher than 96 can be prepared is at this time a matter of conjecture. When one remembers that uranium was the heaviest known element for so many years and was then forced to give up its position to four more elements in a very few years, it is tempting to guess that it will be only a matter of time until even more elements are added. •

SOLUTION OF CURIUM in capillary tube photographed by its own light.

Science and the Nation

(*Continued from Page 91*)

the field of synthetic rubber is a matter of national wisdom, and similar programs are needed in other fields, many of them not of such vital concern on the surface. For example, a national program of basic research on optical glass is a primary desideratum, and yet the thought of the importance of optical glass is not likely to occur to those not engaged directly in military problems because the annual requirements of this country for precision optical instruments for civilian purposes during a period of peace are almost negligible when compared with the demands made upon our industry by our military agencies during war.

Here is a field in which we were long dependent on European developments. Prior to the first World War, all optical glass used in this country was imported from abroad. It was during this period, under the sponsorship of the Navy, that the Bureau started experiments on the production of optical glass and succeeded also in fulfilling military requirements during that conflict, but this was possible only because the United States did not enter the war until the fighting in Europe had been going on for over two years. In the years between World War I and World War II, experimental work was supported at the Bureau by the Navy Department as a hedge against any future emergency, and the foresight of the Navy Department was amply rewarded in the recent conflict, for not only were satisfactory types of glass available as a result of prior experimentation, but actual production in this emergency period was necessary by the Bureau, attaining a peak of 236,000 pounds in 1943. Moreover, the Bureau was able to train industrial engineers and technicians so that their plants could enter into the production of this specialized kind of glass, and assistance was rendered to other branches of the military establishment.

If we are to be again prepared for future eventualities, a program of research and experimentation must be maintained. Stockpiling of optical glasses is not a solution, for stockpiles tend to maintain the status quo, saddling the military services with obsolete instruments and making the introduction of better glasses and instruments difficult. As a general rule, with valid exceptions only in the case of basic raw materials, stockpiling is futile for it tends to hinder progress.

A progressive research program is the only sensible solution, involving the development of new types of optical glass, analysis of the chemistry and physics of such glasses, the development of new and more efficient methods of making and processing optical glass, the investigation of new optical materials for such systems as the ultra-violet and infra-red, studies of polished surfaces, and the development of control methods in production of highly precise optical components.

Research in Buildings and Structures

Finally let me mention a field somewhat removed from pure science and related more to applied science and engineering: building technology. The need for research in this field needs no stressing in this critical period of housing shortages, but it is significant to note the technical reasons behind our apparent backwardness in this field. In almost every field where American science and industry have teamed together to produce spectacular results, production has involved a centralized operation —for example, the production of automobiles, tires, typewriters, and so on. In the building industry, however, no single firm has specialized in the production of a building as such, and practically every material and product known enters into a completed structure. In each of the fields supplying components for a building, research has been done, depending on various conditions, too many to outline here, and varying tremendously in extent and scope. No one, on the other hand, has attacked the problem from an integrated point of view, with the single exception, to my knowledge, of the work of the Bureau of Standards in building materials and structures.

Even here, as a result of the extremely limited funds granted for this purpose, the attack has been on a relatively small scale. Recently all of the sections engaged in this type of work at the Bureau have been unified into a consolidated Building Technology Division, and an accelerated and coordinated program is underway. Groups are engaged simultaneously in investigations of the properties of materials: structural strength; fire resistance; acoustics and sound insulation; heating, ventilating, and air conditioning; durability and the exclusion of moisture; building and electrical equipment; and other projects.

Unified scientific research in other fields of industry has been responsible for productive results, and it is reasonable to assume that the effect of this approach, applied generally throughout the 10 billion dollar construction industry, will achieve similar results.

Science and Man's Other Activities

Even these few illustrations indicate that science does not function in a vacuum, divorced from everyday life. It is a preeminently practical thing, dealing with crucial problems affecting industry, business, the nation, and the world. It costs money and it demands the efforts not only of scientists but of every segment of our population. Too often science is pictured as an "ivory tower" affair with no or little relation to reality. On the contrary, it is concerned immediately with the nature of the universe. It is the cause of our industrial economy, and it operates within the full context of social existence, and it deals with practical problems as much if not more than with theoretical ones. One of the discouraging attitudes widely prevalent in the contemporary world is the high regard placed upon what is called "practical" and the low esteem granted the "theoretical." In point of fact, the two differ only in time, relative to application; and pure, fundamental knowledge precedes applied knowledge.

The operations and progress of science can therefore be understood fully only in terms of the framework of our general society and in relation to the other activities of man. This context is particularly significant when we consider that science has now placed in our hands tools that are equally potent for good or evil. I have been talking, for the most part about the good, but actually the potential evil is more important because—of what value is this growing potential of good if science is used to destroy the civilization from which it has sprung?

It is fashionable to cry down the so-called pessimist who suggests this dangerous possibility, partly because no one loves a pessimist, partly because man is largely a hopeful creature with a belief that at worst he will muddle through, and largely because the dangers are difficult to group and appraise as a consequence of the staggering difference in kind and degree of present dangers in the form of scientific warfare. It is sufficient to say for my purposes that science has presented us with several weapons each of which unleashed can mean almost total, if not total, destruction.

The question then is how to prevent such a situation. The answer is not to be found in the physical sciences. It is to be found in other realms of man's activity—in economics, in sociology, and in political science. Man's conduct in the physical sciences is rational; in these other fields it is largely arbitrary.

Research in the "Humane" Sciences

It is often said that man's social irrationality is a consequence of the fact that economics, sociology, and political science, are not sciences, that they are merely individual judgments and personal opinions. Now this is palpably untrue even at present, for much is known about cause and effect in these fields, and such statements are made only because habit, custom, tradition and heritage tend to make us cling to whatever we know rather than to reexamine the data, coolly and critically. So far no readily demonstrable experiments exist in what I shall call the "humane" sciences as exist in the physical sciences.

Admittedly, these "humane" sciences are younger than the physical sciences. Moreover the variables to be accounted for are vastly greater than those we deal with in the physical sciences. But these are not adequate reasons for belittling the "humane" sciences and denying them support. On the contrary, these are compelling reasons for supporting them, and the present state of civilization demands that they receive this support. As a matter of fact, since the physical sciences have outstripped man's capacity for using them wisely, sanely, religiously, it is of the utmost urgency that we attempt to forge ahead in the "humane" sciences lest all be lost.

And this is the time for intensified activity in these fields, not only because of the urgency of our need but because now the physical sciences have two tremendous tools to contribute to the "humane" sciences, tools that will permit "scientific" analysis of data having a large number of variables.

The first of these tools is statistics which provides the theoretical, mathematical basis for analysis, the mathematical techniques for handling data, and the criteria for evaluating results. Mathematical statistics is now a substantial and well-developed discipline, and it does, in fact, offer these tools. Automatic electronic computing machines, on which many laboratories and companies are at work, constitute the second tool shortly to be available to the "humane" sciences. These machines will permit the handling and analysis of data, rapidly and comprehensively. Until the present, one of the major problems in fields where vast amounts of data are obtained has been the handling and classifying of the data. Literally thousands of man-days are needed in even relatively simple problems. This means that research is expensive, and the "humane" sciences have not usually been able to afford such luxuries. As an example of the labor involved in handling data of this type consider a relatively simple problem. At the present time, a typical census problem involving 100,000 pairs of five-digit numbers, representing statistical data, takes approximately 12 working days exclusive of card handling and data punching. An electronic digital machine will handle the same sequence in 10 minutes at the most.

The Steelman report does not consider research in the economic, social, and political sciences. The study of the physical sciences in itself was a major effort, requiring five volumes of summary findings. It is to be hoped, however, that a similar analysis of the "humane" sciences will be made in the near future and that a program for these sciences will be mapped out and implemented.

Research in the "Mental" Sciences

Just as there is a disparity in the evaluation of research between the physical and the humane sciences, so too there appears to be an analogous disparity in the attitude of most people toward research between the medical and the "mental" sciences. Like the physical sciences, the medical sciences produce what are called "tangible" results—for example, new drugs, new clinical techniques, and so on. Like the "humane" sciences, the "mental" sciences do not appear to produce materialistic results, and have suffered similarly in the support granted them for research. This, too, is a situation that needs remedy. Psychology, psychiatry, and psychoanalysis are disciplines pertinent in the solution of current problems. Aside from the statistical fact that 3 out of every 7 beds in the hospitals of the United States are occupied by the mentally ill—a vast drain in terms of lost manpower and cost—and that untold numbers of borderline cases permeate the entire social structure, we need to know more about the workings of the mind. For there is little doubt but that non-evident factors affect human behavior profoundly, factors like frustrations and fears.

These factors affect every activity of man, his personal, social, political, and even scientific life. From the standpoint of science, we can say not only that science affects individuals and nations but that these individuals and nations affect science. Even from this restricted

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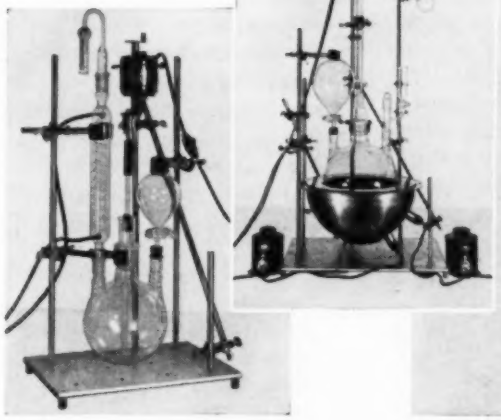

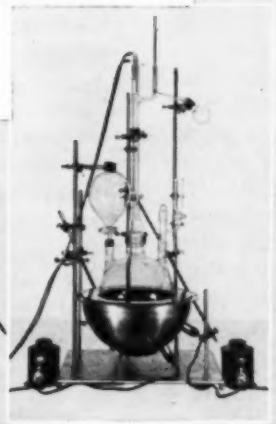

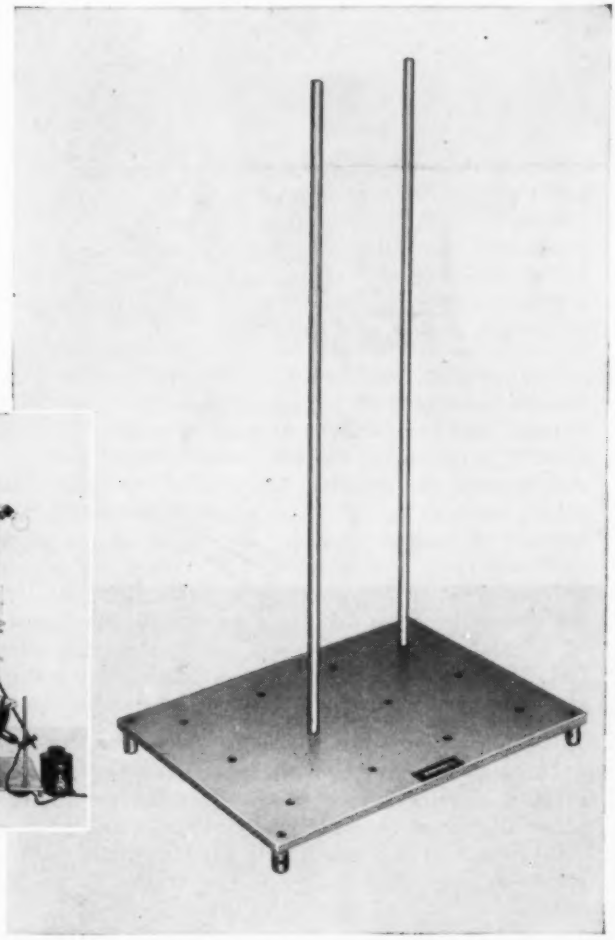

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approach, then, what has happened or happens to men's minds and spirits is of interest if we have scientific objectives in view. We have seen how entire nations have apparently succumbed to a schizophrenia that has led to the espousing of mad, undemocratic, bestial beliefs. We have seen at least one nation despoil its scientists as a result of such an aberration.

Compartmentalization in the sciences and in other fields is inimical to a coordinated attack on the problems of man. This compartmentalization is actually breaking down in the sciences. The distinction between chemistry and physics, for example, has almost vanished. Competent research in the social sciences now depends on mastery of mathematics, and on the utilization of the electronic tools. The complexity of modern life depends on specialization for progress in particular fields but, for overall progress and for a solution to the dilemma of unbalances, integration and coordination are essential. In short, education of a comprehensive nature, embracing many fields, is needed for the survival of our civilization.

The sciences, like those other truth-seeking activities of man, require a free environment, an environment above all free of fear, petty arbitrariness, and tyranny. The pursuit of the sciences is fundamentally nothing more—or less—than the pursuit of truths. In the last analysis, all of man's activities are subservient to what happens to his spirit—to his spiritual welfare, "For what shall it profit a man, if he shall gain the whole world, and lose his own soul?" ●

★ ★ ★ ★ ★

"What, then, is Science? As a first approximation to an answer, we may say that science emerges from the other progressive activities of man to the extent that new concepts in turn lead to further experiments and observations. . . . The texture of modern science is the result of the interweaving of fruitful concepts."

JAMES BRYANT CONANT
Yale Review

★ ★ ★ ★ ★

"All the Sciences are thus perceived to be so many fields wherein God's mind is mirrored in the laws of nature, which proclaim His wisdom and power. The omnipresence of law throughout the vast universe, from the throbbing heart of the atom to the galaxy of stars that swing through the most distant regions of unmeasurable space, heralds the presence of God throughout His creation and makes man feel at home in God's house. . . . Hence the study of all the sciences becomes the deciphering of the divine Mind as reflected in the orderliness of nature whose activities are shot through with plan and purpose from center to circumference."

JOHN A. O'BRIEN
Ave Maria

Properties of Bones

(*Continued from Page 98*)

gage were corrected accordingly and all subsequent measurements were made with the Tuckerman optical strain gage.

The tubular compression specimens failed with a sudden snap and with longitudinal cracking, as did the bending and torsion specimens. The restraint of the special testing jig prevented complete failure of the leaf specimens.

Stress-strain, flexure, and torsion curves plotted from the test data reveal an interesting and significant factor regarding such properties of human bones. The curves are found to lie in approximately straight lines up to failure, thereby simplifying the analysis of the mechanical behavior of the body structure. This means that the load-displacement relations for long bones may be approximated by simple linear equations.

The results of the tests showed the average ultimate strength of the fourteen compression specimens to be about 23,000 lb/per sq. in. The fifteenth specimen, in which the load was applied at right angles to the bone fibers, had about the same ultimate strength, indicating that the effect of the direction of loading on the bone is small. These strength values are in good agreement with those reported by the early German investigators. The strength of the bone in bending, i.e., extreme fiber stress at failure, was slightly lower than the strength in compression. The computed ultimate shear stress for the torsion to failure was about 15 per cent of the compressive strength.

These preliminary data indicate that bone may be considered an elastic, brittle material, having about one-fourth the compressive strength of cast iron and more than twice that of hickory wood. The average Young's modulus of elasticity of the bone, about 2.8×10^6 lb./per sq. in., is approximately one-tenth that of steel, or about equal to that of wood. A simple relation was found between the Young's modulus and the specific gravity of the bones tested.

Plans for the next phase of the Bureau's program include compression tests of an entire human knee-joint in the "standing" position. Loads will be applied to the joint in a manner similar to that in which an actual joint is loaded while a person is standing, and measurements made of the consequent deformation of the joint. This test should provide some data on the "spring constant" of the joint, from which a mechanical analogue may be constructed out of springs or rubber. Also underway is a study of the possible correlation between the x-ray absorption properties of bone and its strength and/or stiffness. Such a relationship would be useful in estimating the strength of living bone from x-ray data. ●

Physical Experiments

(*Continued from Page 96*)

wards. The deviation from the true vertical would indicate the relative masses of the earth, and of the mountain. Since the mass of the mountain could be estimated, an approximation to the mass of the earth could be obtained. In this way K also could be determined.

Bouguer's troubles were not over, even after completing his experiment. "I have already mentioned a passage at the foot of Chimborazo, but there is another pass, infinitely more to be dreaded, and is the most feared in South America; it is named the pass of "Gouanacas." "This pass," he says, "is never hazarded without the utmost dread, particularly when it is taken approaching the eastern side."

> "The mules which are always used on these journeys, on account of their surefootedness and strength, are still more exposed to the dangers of this pass; they have not only, like their masters, to guard against the intenseness of the cold, but they are worn out with fatigue; for more than two leagues on this way, the bones of these animals that have died in this journey lie so thick, that it is not possible to set a foot down without treading on them. I have been obliged to encounter this defile in order to embark on the river Magdalene for Carthagena, on my return to Europe."

• • • • •

In 1930, a redetermination of the constant K was undertaken in the Research Laboratory of the National Bureau of Standards, by Paul Heyl. The method used was essentially that employed by Cavendish's classical experiment. A very light torsion balance is allowed to swing in the vicinity of two large masses, which are placed first in the position A and then in the position B.

POSITION A POSITION B

From the difference in period of the torsion balance in the two cases, the value of K may be computed.

In reporting this work, Heyl remarks, "to conclude the work is a task of an institution rather than an individual. Practically every division of the Bureau of Standards has contributed tangibly or intangibly to the successful completion of this work."

In the past, lead spheres were used as the large masses, but in the present instance it was thought the slight deformation lead undergoes would introduce a noticeable source of error. Lead castings are not completely free from air holes. This unequal distribution of mass in the sphere would also be objectionable.

The Washington Navy Yard was called upon to supply a 30 cm. diameter specimen of hardened tool steel, which was to be forged to 20 cm. to eliminate every trace of air bubble. The mass of the cylinder was determined by the Division of Weights and Measures of the Bureau. The actual experiment was performed in a constant temperature vault 40 feet below the ground; this insured the experiment being independent of any disturbance due to street traffic. Optical interference methods were employed in measurements of length, while measurements of time were made by a constant temperature clock checked daily against the Naval Observatory signals. The investigation required an observer to remain seated before the torsion balance for a period of from six to seven hours, noting the motion of the small balance.

A superficial glance at the two experimenters and their methods might lead one to suspect the demise of the spirit of romanticism in science. However, in the twentieth century, Marconi cruised the seven seas in his yacht studying radio broadcasting; Millikan has traveled from Pikes Peak to India in search of an explanation of cosmic radiation; A. H. Compton led a group of scientists around the world in a study of the same phenomenon; Piccard carried his instruments into the stratosphere.

Bouguer's work, from a strictly scientific standpoint, is crude in light of present day standards. His general method, however, of being willing to go to the ends of the earth in quest of nature's secrets, is as vital today as it was in the 18th century. The work of Bouguer and of Heyl are each integral parts of the development of science. ●

Changes in Starch

(*Continued from Page 95*)

the balloon-like expansions of the second three. They are the result of the exposure of the seeds to 15 seconds of electronic energy—400 kilocycles, 4000 volts. The third group involves a 30-second exposure, using the same source of energy. The fourth group from the bottom shows a continued expansion, after an exposure of 60 seconds. The top three represent an over expansion and bursting of the grains, at 120 seconds. The large central figure on this top row is the granule from corn. It has not ruptured, but the walls appear to be quite thin.

Greenhouse and field trials indicate that 30- and 60-second exposures stimulate growth, but 120 seconds decreases the germination of seeds. Wheat yields show an increase to the 60-second period of treatment; and the best corn and oat yields were with 30-second treatments.

Heat applications from other sources than electronic energy were made, but these did not produce the distortions in starch grains, and they did not stimulate growth. Electronic energy is supposed to heat the internal structures, while the ordinary heating process warms the outer layers. Distortions, dwarfing and abnormalities similar to those from x-rays have not been observed with the wave-length used. ●

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Margarine

(*Continued from Page 85*)

by using a plastic bag. Both Delrich margarine and the coloring "berry" are sealed inside the bag. The user merely pinches the berry to release the coloring and then kneads the bag. In a few minutes, the margarine is blended to a pleasing golden color. It is left in the bag to be chilled, and then may be cut as needed. The plastic film is easily peeled off the section before serving.

In addition to the benefits of easy coloring, the sealed package protects the delicate flavor and freshness of the product for the consumer. Even after coloring the margarine, it remains sealed and is not exposed to the air and refrigerator odors as is the case in an open mixing bowl. Advantages are also enjoyed by the wholesalers, distributors and retailers who handle this margarine. It cannot leak even in the hottest weather.

New Type Packaging Requires Special Controls

The change that this unusual new package made in our margarine processing involves delicate control of crystallization. Before the change, the emulsion was congealed to a firm, hard consistency in a refrigerated machine called a Votator. It was then cut into one-pound prints, ready for wrapping in paper and placing in cartons. Now, our skilled technicians regulate the *extent* of the chilling and crystallizing process. By delicate instruments they control the process in order to produce the exact size of crystals desired, at the proper moment. The product must be soft enough to flow into the bags and yet be crystallized enough to harden quickly as it is placed in the cartons and shaped.

This delicate timing may be likened to that in fudge-making when the candy is still of a consistency to pour and yet will quickly "set" to a firm, smooth consistency after it is poured. In the case of margarine, the smoothness and ease of spreading depend to a great extent on the skill used in this part of the processing.

Quality Rigidly Controlled

Throughout the production of a modern margarine, and before the finished product goes into distribution channels, it must pass rigid tests for quality, purity and nutrition. Each ingredient used must meet specifications based on the highest quality standards. The ingredients are also subjected to laboratory analyses before being accepted for use. As the oils are refined and hydrogenated, they must pass a number of different quality tests. Each processing step is carefully controlled by delicate instruments and precise measurements. Every step is carefully supervised by skilled technicians.

The finished product is tested for the proper analysis of components; thus the consumer is assured full nutritional value in every pound. The food value of the margarine is the precise equivalent of the ingredients which go into the product. For example, the refined, hydrogenated oils, abundant in food energy, must constitute at least 80 per cent of the product. And there must be 15,000 or more units of Vitamin A in every pound.

In addition to the strict quantitative tests, margarine is tested for smooth texture; for delicate, sweet flavor and pleasing aroma; for color; for non-spatter frying.

Consumer Acceptance Increasing

The development of the nutritional benefits of margarine and the perfecting of its flavor, aroma, and texture have helped win greater and greater acceptance for the product by housewives and nutrition experts. In homes all over America margarine is used and enjoyed as a spread for bread, flavoring for such hot foods as vegetables, pancakes, and waffles, as a flavoring and shortening for pastries of all kinds, and as a flavorful fat for pan frying.

Quite naturally, nutrition experts have spent much time and effort studying, comparing and testing the qualities of margarine and butter. They have found that both have about the same caloric value, approximately 3300 calories per pound. They are both highly digestible. The Vitamin A content in margarine equals the yearly average of the same vitamin in butter. The National Research Council's Food and Nutrition Board declares margarine to be "nutritionally equal" to butter. The American Medical Association says:

> "When margarine is fortified with Vitamin A the investigations that have been made lead to the conclusion that it can be substituted for butter in the ordinary diet without any nutritional disadvantage."

The increasing acceptance of margarine is shown in consumption and production figures. Before World War I, the per capita consumption of margarine was about one pound a year. Since then, the yearly consumption has gradually increased until today it is approximately five pounds per capita. In 1915, the production of margarine was 141,969,400 pounds. Output in 1947 totalled over 700 million pounds.

"Cinderella" Margarine Transformed by Wand of Science

The story of margarine has been the story of a "Cinderella" food product. In its original form during the time of Napoleon III, it was a rather miserable concoction. It did not have the "social graces" of delicious flavor and abundant nutrition. For years margarine was kept in the background, socially speaking, even though its use gradually increased. But it was touched and permanently transformed by a magic wand—the wand of American scientists and nutrition experts. Their kind of magic worked slowly but surely. Today, margarine has emerged as a delicious, wholesome, nutritious food. It has "arrived" socially. It is praised by consumers and experts. It is served and enjoyed in the homes of millions of Americans. ●

Isotopes for Freshmen

(*Continued from Page 94*)

examples in this connection. Some, in addition, mention stable isotopes. As might be expected from the availability of many techniques and experimental results in this field, the examples chosen are in great variety and are explained in all degrees of completeness.

Discussion and Recommendations

The ideal means of presenting the subject of isotopes from the standpoint of mass spectroscopy would include a good diagram and explanation of a mass spectrograph and a good reproduction of a plate or figure of the analysis of an element of simple isotopic composition. The reproduction should show not only the presence of the different isotopic species, but also should indicate clearly their relative intensities, hence natural abundances. The accompanying explanation should point out that the isotopic spectrum of the element can be used to calculate its weighted average atomic weight. Then the computation should be performed in the text, and the result compared with the chemically-determined atomic weight. In general, most of the texts considered in this survey in one respect or another do not fulfill these recommendations. For instance, two offer no discussion of fractional atomic weights. Others give an inadequate diagram or explanation of the mass spectrograph. Some give a calculation of the fractional atomic weight of an element with two isotopes, but reproduce the mass spectrum of another element, usually a relatively complicated one like cadmium or tin. This practice takes away from the student the lesson of following the calculation of the atomic weight from the experimental data represented by the plate or figure.

The definition of isotopes in most texts appears typically as follows. "Isotopes are atoms of a given element which differ in mass but are identical in chemical properties." The unfortunate persistence of this concept has continued from the early studies of isotopism among the radioactive elements. Although it is true that the differences in the chemical properties of the isotopes of the heavier elements are not very pronounced, and no doubt they are undetectable by many experimental procedures, nevertheless the very existence of exchange reactions among the isotopes of the lighter elements shows that chemical identity among the isotopes of an element is not a general property of the elements. Any reference to the chemical identity of the isotopes of a given element has no place in the general definition of the term. There may be some who will defend the typical definition by saying that for ordinary reactions the chemical properties of isotopes of an element are practically identical. The trouble with the qualifying words, "ordinary" and "practically", lies in the fact that they are relative. In the progress of science, that which seems most unusual and of little or no practicability when discovered and for a time thereafter, eventually is described in a most casual manner.

Early attempts at the separation of isotopes by fractional distillation and fractional diffusion involved unusually laborious and tedious procedures, giving results which were barely significant. Today, some isotopes are separated commercially in bulk for a variety of "practical" purposes. For the biochemist interested in following the metabolism of nitrogen compounds labeled with N^{15}, the fact that this heavy isotope can be separated on a large scale from the lighter and more abundant N^{14} by chemical exchange is most fortunate and practical. It is fortunate because no suitable radioisotope of nitrogen can be prepared, and it is practical because of the ready availability of this heavy, less abundant isotope. In view of these considerations and others which could be cited, isotopes of an element should not be described as having identical or practically identical chemical properties.

As we have stated, there is a tendency to introduce isotopes early in the course. When this is done, however, further application of the phenomenon of isotopism is generally not very extensive. There is an inclination to overemphasize hydrogen and uranium as examples of separating and using isotopes. Although the importance of the isotopes of these elements cannot be questioned, it does not seem wise from the pedagogical point of view to rely mainly on the lightest and heaviest (natural) elements as typical examples. Rather, as the course develops, the subject of isotopes can be kept "alive" by discussing the existence, separation, and uses of isotopes in the chapters which are devoted to the descriptive chemistry of the elements and their compounds. It is not inferred that every element should have its stable and unstable isotopes listed and described. Such a time-consuming practice would be boring both to student and instructor. But a judicious choice for this treatment of one or two elements in the various groups and sub-groups of the periodic system, as these groups are studied throughout the whole course, would expand gradually the student's appreciation of the general phenomenon of isotopism and its importance. ●

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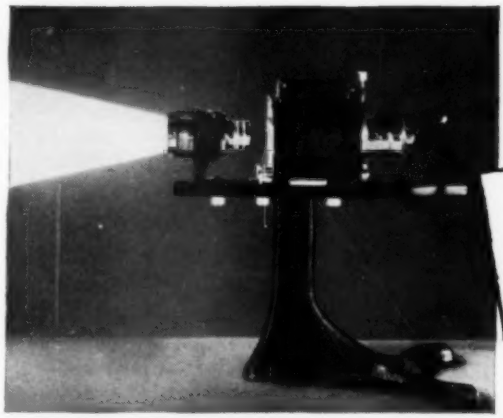

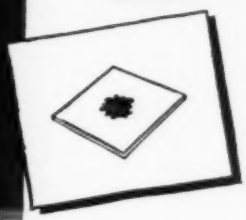

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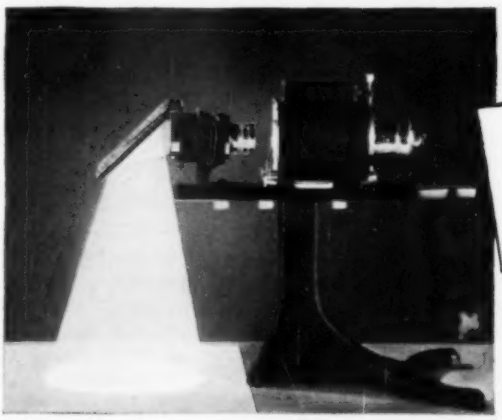

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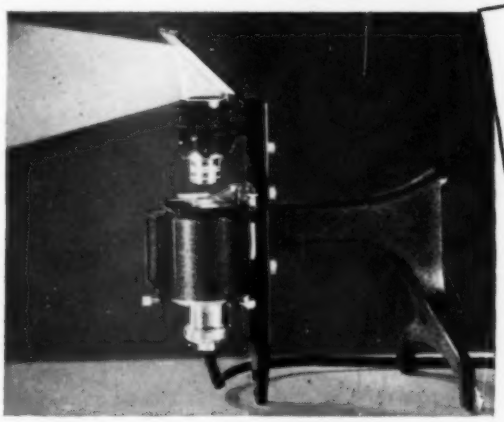

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Distribution of Trees

(*Continued from Page 88*)

is well represented in Louisiana and Texas. Illick, in his *Pennsylvania Trees*,[4] makes the statement that it is found locally in Pennsylvania in the eastern and southern parts, "but not in the southwestern and northern." At this point, he mentions that it is locally common near Mont Alto, Franklin County. Hough,[5] using the synonym, *Quercus minor* (Marsh, Sarg.), gives a distribution map which indicates that it may be found throughout Greene and Washington Counties and even into Allegheny and perhaps Beaver counties.

In 1922, while the author was leading a field trip, he discovered a single specimen growing at the head of Smith's Creek, Greene County, where the road branches towards Kuhntown. The specimen was on the upper side of the road about half way to the top of the hill and was estimated by the author to be somewhere between fifty and seventy-five years old. This remained the only station in Greene County until, in 1934, a reward was offered to the various public schools of the county for information concerning other locations of this tree. This led to the discovery by William Turner, of Jefferson High School, of the very finest stand in the County. (The author recommends this procedure for other counties and for other species. School boys are ubiquitous and are naturally keenly observant.) Thirteen trees of acorn-bearing sizes were discovered on the Blackledge farm on the short cut between Jefferson and Clarksville. This stand was unusually valuable in that the trees showed leaves of all kinds of variations from the simple to the double and even the triple maltese cross. In 1944, the cyclone which swept across Greene County, laying low the town of Chartiers and causing some loss of life, chose this grove as part of its itinerary. Every tree was torn to pieces, leaving, however, quite a multitude of small bushes, which are now recovering and will in this natural sandy habitat, if undisturbed, make another fine stand.

In 1935, Ben Donley, mentioned in the article on *Gymnocladus*, discovered a large tree, considerably past its maturity and having a diameter of two and one-half feet, on the alluvial terraces in the environs of Carmichaels, Pennsylvania. This tree was remarkable inasmuch as it is rarely mentioned by the authors as growing on alluvial soil. Sargent says, "dry gravelly or sandy uplands," and later, "Rarely in the moist soil of low lands."[6] This specimen was also remarkable in that it possessed crimped and curly leaves, such as are found often in juvenile trees and seedlings. The author considers that this may be due to the rich soil rather than to mutation. Unfortunately, the housing project in 1938 completely wiped out this valuable specimen.

Fetid Buckeye
Aesculus Glabra, Willd.

Illick reports the distribution of this species as, "Found only in the extreme western part of the State. Reported from Allegheny, Fayette, Lawrence, Mercer, Washington, Greene, and Westmoreland counties."[7] In Greene County we find this species in a few spots, such as Springhill, Aleppo, and Richhill townships, along our western border. A point of interest worth noting lies in the fact that we have determined the exact eastern extent in the County. Professor A. J. Waychoff, about 1920, making a survey of this species, discovered that it extended into Center Township to the locality now known as Golden Oaks Park, one mile west of Rogersville.

Yellow Birch
Betula Lutea, Michaux

During the years 1929-32, certain students from the southwestern part of Greene County reported that they had found yellow birch (*Betula lutea*) along the banks of Dunkard Creek. Examination by the author seemed at first to establish the presence of this species, but more careful examination indicated that this specimen was not the true lutea. It occurs unpredictably along lower Dunkard Creek, either associated with *Betula lenta*, or independently. It is probably the species referred to in the Herbarium at the Carnegie Museum as *Betula Allegheniensis*, (Jennings).

Illick mentions *Betula lutea* as being "rare or absent in the southeastern and southwestern parts."[8] This *Allegheniensis* is by no means uncommon along lower Dunkard. Large numbers of specimens may be found by any observer in this region.

Yellow Oak
Quercus Muhlenbergii, Engelmann

Until 1920, this species was not reported from Greene County. Illick states, "reported from Beaver and Lawrence counties in the western part."[9] In 1920, George Parker, visiting Greene County, found a single specimen one mile southwest of Rogersville. Its discovery occasioned considerable interest, and the resort known as Golden Oak Park was named from a false interpretation of the name yellow oak. Since that year, the investigations of the author have led to its discovery on the banks of all the streams of Greene County. Its habitat is peculiar. Practically all the specimens seem to be found in an elevation belt from within a few feet of the stream to approximately 150 feet inland from said stream. Among scores of specimens examined, only one is found outside of such a belt. This specimen is a large well-formed one, growing approximately halfway between Carmichaels and Crucible, to the left of the road on the John Patterson farm. This oak grows in a pasture field, albeit within 20 feet of a small swampy seepage stream. The reason for this peculiar distribution is not known to the author. He would like further comments. Trees transplanted by the students to

the Waynesburg College arboretum seem to grow well in any locality in which they are placed.

Bur Oak

Quercus macrocarps, Michaux

The author mentions this tree because, although it is found in several stations in Washington County, Pennsylvania, he has never heard of its being reported from Fayette County or from Greene County. It seems to have crept into the southwestern part of the State from Ohio, where its deployment as a species is well marked. Illick states that it is "rare or local in the eastern, southern, central, and western parts of the State."[10] The author would like to have other observers seek for it along the northwest borders of Greene County. ●

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★ ★ ★ ★ ★

"But liberal education is not everything except science; it is not a remnant of "other things" toward which we must be pious. If science is master of the intellectual arts proper to the conduct of its affairs, then science is liberal too; and letters should learn from it how to be something better than the extra, the additional, the amateur army they now seem to be. Science has no doubt of its importance. Letters must have, or they would not speak of themselves as "also important."

MARK VAN DOREN
Liberal Education

★ ★ ★ ★ ★

"Finally, it must be remembered that the compensation of the teacher is not represented by the salary he receives or by the academic rank he holds: much of his satisfaction comes from work well done in an atmosphere which is conducive to high ethical standards, human sensitiveness and productive scholarship. He loves his work and derives satisfaction from the successes of his colleagues and students. The teacher is certainly fortunate in the rewards and satisfactions of life which his calling affords him!"

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Science Teaching Problems

(*Continued from Page 82*)

facts, ideas and information, then we might well argue that since the world has so many more facts and ideas, so much more information than it had a decade ago, we ought to increase high school to five years or college to five years. To be consistent we would then, at some later date, be called on to increase high school to six years, and so on. If we set as the objective of general education the development of personality, training in thought and action, attainment of proper social consciousness, the acquisition of ideals, to mention just a few, then there is no very good reason for adding an extra year. One might, in fact, argue that, since young people have opportunities for much broader experience today than they did 20 years ago, the *general* high school and college courses could be reduced in length.

When a student goes to college or university to train himself for a particular job which requires that he have a fund of special abilities, special facts, special information, the situation is quite different. Such a student very generally needs more training than he is now getting. Either he must go to school longer, or he must take a heavier load, or his requirements must be changed so that he can take a higher percentage of specialized courses, or his whole educational program must be revamped so that he can start specializing earlier in his school career. Of these possible alternatives the lengthening of his school career should be the last resort, a carefully planned revamping of his educational program should be the first.

This revamping should start with the high school course and should proceed on the premise of close coordination and cooperation between high school and college. The two will function together, each with a job to do. The resulting planned program should provide sound basic training in mathematics and a uniform course of study in the elementary sciences. It should establish high standards of quality and attainment which will protect both the student and the teacher by insuring that no student is permitted to enter any field of specialized training until he has demonstrated his ability to meet the special requirements of that field.

Such a planned program would provide the answers to the last three questions asked above. It would allow the student to devote more of his college career to specialized courses. In such a program the time-credit dimensions of the elementary science courses could, if necessary, be increased to take care of the increased material content. One might hope and expect that, with the better trained high school graduates which such a program would bring to college, general chemistry, with all of its new material, could be covered, easily, completely and thoroughly in a two-semester ten-credit course.

In any program intended to improve the effectiveness of elementary science teaching something should certainly be done about textbooks. A good textbook is an absolute necessity for effective teaching of elementary chemistry. It is probably not fair to say that there isn't one really good college grade general chemistry textbook, but it is certainly true that there are very few good ones. Most of them are entirely too large, and they are getting larger and larger. Actually most of them are reference books, not textbooks. Textbooks should be designed for good teaching and good learning, not for reference. They should be written for the student, not for the professor. A good elementary college textbook should contain no more material than can be covered, well, in the course. The material should be arranged so carefully and logically, should be stated so clearly and concisely and should be followed by the teacher so closely that, if for one reason or another a student fails to grasp the content of a certain section or even misses school entirely for two weeks, he can be directed to specific consecutive pages in the book and will, by studying those pages, be able to fill in, completely, the material that he has missed.

The theory, widely expressed, that a textbook should be comprehensive, that it should contain more material than can be covered in the course, that it should require of the student that he use judgment in the selecting and sifting of material, does not work out in elementary science teaching. A first year college student is just out of high school. He hasn't yet learned to select and sift. He doesn't know what to select and sift. Provide the student with a well stocked reference library where he can ramble and read to his heart's content, give him reference assignments that will help teach him to select and sift, but let his textbook be brief, concise and well-written. There is no substitute for good teaching, but not even a good teacher can do a completely satisfactory job with a poor and inadequate textbook. ●

Conductivity Demonstration

(*Continued from Page 97*)

tion of 0.1N sulfuric acid from the buret the precipitation of barium sulfate, the extinction of the lamp, the discharge of the phenolphthalein color, (at this point methyl orange indicator solution is added) the change in the color of the methyl orange, and the reappearance of the light may be successively observed. This serves as illustrative material for a discussion of concentrations, conductivity, titration and indicators. ●

Conservation Education

(*Continued from Page 100*)

At one of Pennsylvania's ten well-equipped, well-managed fish hatcheries the teachers became acquainted with the measures involved in keeping the miles of clear mountain streams well stocked with fish. The problems of artificial reproduction, feeding requirements, disease and the transplanting of desirable species of trout and bass were explained. Teachers waded into a typical stream to examine the variety of living organisms which comprise the food of native fish. These experiences provided a keener understanding of man's manipulation of the balance in nature to provide a source of healthful recreation as well as delectable food.

The problems of wildlife management in the state as well as in the nation were ably demonstrated. Through field trips to state game lands where abandoned farms were under management to promote wildlife protection, and excursions over major land types, teachers saw typical plant succession and land use practices employed in their relation to wildlife. As the teachers explored the haunts of the elusive woodcock and grouse —saw excavations made by woodchucks, foxes and field mice—enjoyed the aesthetic pleasure of the song of a bird, the sight of a deer, the sound of a grouse being flushed—they saw through the eyes of research the scientific basis for planned practices of protection, wise management, and the need of laws.

Evening sessions brought the group sources of visual aids available for classroom use.

Integration of the factual material and information gained through field experiences into subjects already taught in the regular school curriculum occupied teachers' attention in evening sessions. Suggested activities and projects conveying conservation concepts in terms of the experiences of the various age groups from the first grade through the high school level were presented.

Because conservation is a way of thinking, even a way of living, most educators who have given thought to the matter believe conservation should be a part of every subject taught rather than a separate subject in an already crowded curriculum.

The teacher in reshuffling his ideas and values will find help awaiting him in publications of various agencies. The United States Soil Conservation Service, the U. S. Forest Service, the U. S. Fish and Wildlife Service, the U. S. Office of Education are ready to help—as are state departments of education and state departments of conservation. In Pennsylvania, the Game Commission, Fish Commission, Department of Forests

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and Waters, Department of Public Instruction, Sanitary Water Board, State Planning Board and county farm agents are helpful.

Planners tell us their most difficult task is to make citizens realize the problems facing the community and the nation. The teacher can be all-important here in teaching pupils conservation problems and in driving home the fact that they are problems that affect every citizen.

Each resource offers individual pupil activity both in and out of the classroom if the teacher will exercise his ingenuity or consult the rapidly growing literature of conservation education.

We would do well to follow the slogan Ohio has offered its teachers—**"Teaching Conservation—A Year Round Responsibility of All Teachers."** ●

The Palomar Giant

(Continued from Page 84)

this model the astronomer must stay outside to do the guiding.

When directed to the zenith, the tube stands nearly six feet from the floor to the top. It is built entirely of cast aluminum structural members, and weighs approximately 95 pounds. The supports for the telescope are the horseshoe at the north end, two stainless steel welded tubes along the sides, and another fabricated yoke at the south end.

Weighing well over 300 pounds because of its all-steel construction, the north pier is the most massive single member, carrying at its top the girder which supports the four oil-bearing pads upon which the journal bearing rests. The south polar bearing consists of a 6-inch bronze hemisphere supported by three oil-fed pads similar to those at the north end.

The telescope is driven in right ascension by a 1 r.p.m. synchronous motor, through 60- and 24-tooth worm wheels. The 60-tooth worm does the driving and floats on the polar-axis shaft, which is really a hollow tube. Driving contact is established by a switch which energizes a magnetic clutch, fastened to the south polar axis. This causes the clutch to adhere magnetically to the rotating steel worm wheel, carrying the telescope along with it. This clutch is quite interesting, and required considerable research before it could be constructed. It consists essentially of four coils in a unit attached to the polar-axis tube. Each coil is built of sheet-iron laminations, individually insulated with paper and shellacked to insure molecular flow in one direction.

The clutch is energized by batteries; the switch being so arranged that when the clutch is disengaged, the direct-current lag is removed by demagnetizing the cores and the steel right ascension drive worm by instantaneous application of eight volts of alternating current supplied by a transformer.

For fast motion in right ascension, there is another floating gear on the same south polar axis, with another magnetic clutch to engage it. This "slewing" gear is driven by a reversible motor, controlled by a four-way switch on an independent control panel, where all controls and setting circles are mounted. Another reversible motor operates the drive in declination. Attached to the telescope itself are two Selsyn motors, synchronized with their mates on the control panel. Through them the position of the telescope is indicated by right ascension and declination dials.

As in the Palomar "Big Eye," the oil-flotation system was used for the main bearings. There are four pads at the north bearing, three at the south. Oil is supplied to the face of each pad through four tubes imbedded in its babbitt face; these tubes lead to a recess in the pad which is kept supplied with oil under sufficient pressure to raise the entire mounting about 0.0015 inch from the pads.

The oil is fed by $\frac{3}{16}$ inch tubing which leads from a tank kept under air pressure supplied by a compressor operating at 75 pounds. This compressed air passes through a sensitive reducing valve by means of which the pressure of the oil is regulated to keep the mounting floating without having the oil gush out of the pads.

There is a slight seepage here, and this waste oil is drained through leaders to a storage tank for future use. In all, 10 brands and viscosities of oil were tried before a satisfactory one was found.

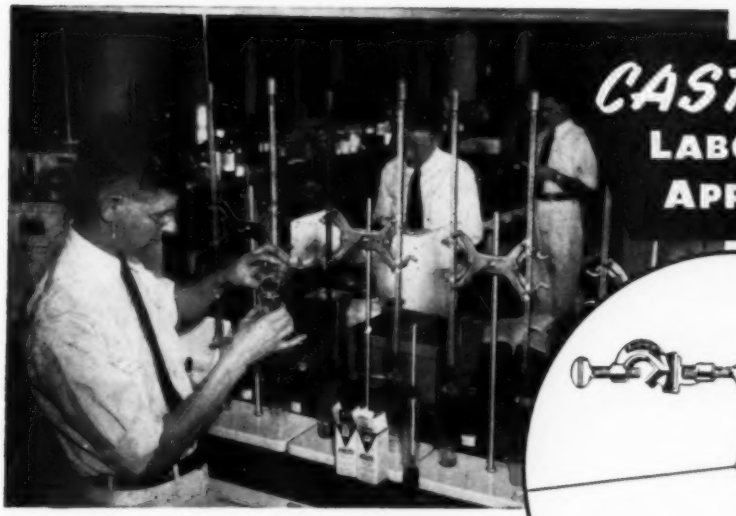
During one of the test runs, Mrs. Raible was "invited" to watch. It may have been the tension of the moment which caused Cliff to release the pressure too suddenly—result: a fan of oil leaping from between the pads and journal bearing which completely ruined one dress!

After that somewhat drastic experience, no amount of cajoling could induce Mary Raible to watch the oil tests, but that did not prevent her from giving willing assistance when heavy parts were ready to be mounted or assembled.

The most valuable contribution which Mrs. Raible made to the successful completion of this wonderful working model was of a passive nature. Cliff spent his week-ends almost entirely in the cellar, often working from early morning to midnight, and quitting only after his wife's insistence.

Keeping warm in winter was not much of a problem when castings were being poured. Frequently the forced draft on the hot-air furnace necessitated opening the windows to prevent suffocation, and the neighbors wondered why Mary sat fanning herself on a chilly day. If they could have looked into the basement and seen Cliff ladling out the molten aluminum or bronze from the white-hot furnace, they might have understood that in making such a telescope, you need not only complete plans and large quantities of materials, but also endless patience, skills, resourcefulness, ingenuity, and most of all, an understanding wife! ●

Technical information on Mr. Raible's model supplied by Mr. Leo Scanlon, member of the Amateur Astronomers' Association of Pittsburgh, and one of the city's leading astronomers.



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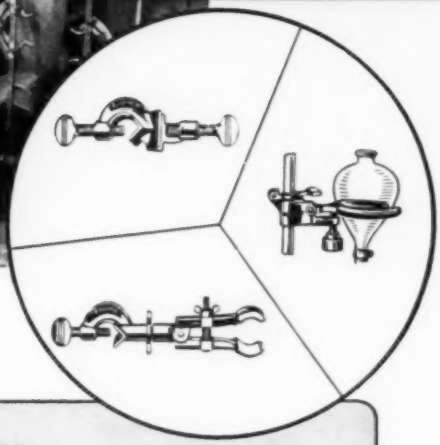

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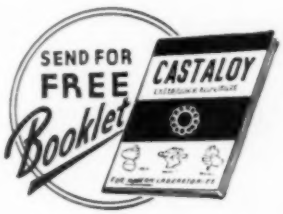

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